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AN ESKER IN THE PLAIN.

By Grenville A. J. Cole, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

THE gravel ridges of the Irish plain have been already mentioned* as a welcome feature in its landscapes. These "green hills," with their pleasant grassy slopes, have often given a name to groups of houses clustered near them; and here and there they were seized on long ago as sites for commanding forts. The Irish word *eiscir* means "a ridge," and there is a hamlet called "Esker" to this day on a gravel bank near Lucan. The term has, however, become a scientific one, through the interest roused among geologists by the characters of many of these ridges; and General Portlock,† Mr. G. H. Kinahan, and, finally, Mr. Maxwell Close,‡ have distinguished between *eskers* proper and the fairly parallel banks of drift, or *drumlins*, which are found so abundantly in glaciated countries.

We need not go far from Dublin to find a typical little esker. Four miles south-west of the city, out in the limestone plain, the main road to Tallaght makes a sudden rise, and reaches the crest of a green ridge on which the hamlet of Balrothery stands (Fig. 1). Gravel pits have been opened on either hand, and a by-road turns off along the ridge, which it follows for some three miles to Crumlin. Such a road is in itself a feature of an esker; these dry raised causeways offered themselves to the ancients ready-made; and the fact that they seldom ran in a straight line was not in those days of much importance. If we start from Balrothery, we at once note that the esker is formed of irregular beds of pebbles, with occasional yellow sands. At the summit it is little wider than the road, and falls with a slope of twenty degrees on either hand; from its base there is a gentler slope to the ordinary level of the fields, doubtless due to the washing down of detritus from the ridge. Before us, planted on the crest, rises the tower of Tymon Castle, one of the defences of Norman Dublin against the Irish; and the road has to give way and descend round about it. The west slope has here an angle of nearly thirty degrees (Fig. 2). Soon we reach Green Hills, where the inhabitants are engaged in quarrying, and where large sections have been opened in the esker. Here the ridge broadens and becomes less defined, and finally breaks up into a number of mere mounds of gravel.

When once recognised, such a feature will be picked out again and again in a traverse of the Irish plain. Gravels are common on its surface, largely composed of limestone pebbles, with a sprinkling of other rocks, which can generally be traced to the highlands of the country along one or other line of ice-drift. The pebbles of the plain are ground and striated on their surfaces, and clearly were at one time under solid ice, or embedded in its moving layers. When, however, we examine the material of the eskers, we find the same pebbles, but with subsequent signs of water-action. Here and there the old striæ remain; but in most cases further rounding and abrasion have gone on. The bedding, whether in the rough layers of the gravel, which are seen to dovetail into one another in the sections, or in the delicate stratification of the brown and yellow sands, reminds us at once of the river-deposits that are laid bare by Alpine streams. But in the esker the form of a stream-deposit is reversed; instead of an alluvial mass, filling up the groove of a valley-floor, and widening from below upwards, we have the narrower part at the top, and a pebbly ridge has been heaped up without visible retaining walls.

The sharp ridges formed by the lateral moraines, as a glacier shrinks in its own bed, will come to the mind of any traveller. But these occur in pairs, or series of pairs, marking successive halting-points in the transverse shrinkage of the glacier. They curve round, moreover, towards the terminal moraine at the nose of the glacier, and are altogether more systematically disposed than these eskers of the Irish plain. Further, their materials are just dropped off the edges of the ice, and are not specially waterworn.

Rivers, again, do not form isolated ridges of detritus, although they may raise their courses above a plain on broad strips of pebbly land, which they themselves have formed. For a long time, the movements of currents in a shallow sea was invoked to account for the building of eskers, and their various curvings and bays were held to mark swirls of water along which the pebbles had become accumulated. Marine shells, however, could not be found in the esker-gravels, though they are plentiful in some

* Knowledge, Vol. XXI., p. 75. (April, 1898.)

† "Report on Geology of Londonderry, Tyrone, etc.," 1843, p. 639.

‡ "General Glaciation of Ireland," *Jour. R. Geol. Soc., Ireland*, Vol. I. (1867), p. 211 and p. 212, footnote.

other deposits of the Ice Age. Nothing like a true esker could be quoted, moreover, from the sea-banks now forming off our shores. The North Sea, at any rate, should have given us some clue to their formation; in the absence of such evidence, the marine theory was adopted with considerable reserve.

Prof. Sollas,* in his valuable review of the history of the subject, points out that Mr. N. H. Winchell and Mr. Warren Upham in America were among the first to show how mounds and ridges of gravel could accumulate at the base of crevasses in a glacier, and how they would come to light on the final melting of the ice. But Mr. J. G. Goodchild, on our side of the Atlantic, was at the same time elaborating his views as to the distribution of materials carried in the body of the ice—such materials as we now call "englacial" or "intraglacial." In a paper on the Eden Valley,† read in 1874, Mr. Goodchild gives

Fig. 1.—View from the road along the Esker at Balrothery, showing the low Gravel Ridge, and the Dublin Mountains in the distance.

the gist of the matter in this sentence:—"The angular moraine-like drift occasionally found in parts of the dales, the upper and lower tills and the intercalated beds, the deposits of sand and gravel that form the eskers, and, finally, the numerous boulders that are left at nearly all elevations, are each and all the results of the melting of a great sheet of land ice that was charged throughout with rock-fragments of all sizes and of all kinds occurring within the area wherein the ice originated." Mr. Goodchild held that eskers were formed where materials in the lower part of a melting ice-sheet were arrested by some underlying ridge of rock. The water would run on either side, and would leave a long bank of pebbles to mark the line where scouring action was least, *i.e.*, the line between two adjacent subglacial streams. Simultaneously, Dr. Hummel in Sweden was putting forward his view that the eskers accumulated *in the channels* of such streams, and that they are casts, in fact, of the grooves worn in the bottom of a glacier by the streams that issue from it. Good accounts of Hummel's paper are given by Prof. Jas. Geikie* and Prof. Sollas, and the former practically introduced it to English readers. Dr. Holst, in 1876, urged that pebble-accumulations in the beds of rivers on the surface of melting ice may in time be lowered, by melting and excavation, until they are left as ridges on the glacier-floor, when this finally comes to be exposed. Like Goodchild, Holst lays stress on the amount of intraglacial material, which would fall out into the stream-channels as they cut more deeply into the ice.

In the last twenty years, as may be seen from Prof. Sollas's review, opinion has favoured the explanation given by Hummel rather than that of Holst. Prof. I. C. Russell has, moreover, seen eskers in course of formation in Alaska,† and to his account of the Malaspina glacier we shall have occasion to return. His remark that such deposits are typically associated with stagnant ice-sheets which are wasting away, may account for the disappointment felt by those observers who have failed to find modern eskers under more normal types of glacier. One might surely, however, have expected to meet with sub-glacial eskers in Spitzbergen; yet Messrs. Garwood and Gregory‡ are obliged to report that evidence regarding them is absent.

These two authors, in their crisp, condensed, and unspeculative record, give strong support to Mr. Goodchild's theory of the importance of intraglacial drift. The waste material of the highlands round about a great glacier-basin falls upon the ice, and is gradually incorporated in the mass. It is transported laterally as well as vertically in the body of the ice, and becomes spread out into sheets, forming intraglacial strata. Here and there, by internal surging movements, it may become mingled with detritus that has already been ground against the floor. Ultimately it is extruded to form part of the copious clays, or sands, or gravels of the terminal moraine. The stones have generally been rounded, and are now attacked by the outflowing waters, and are re-arranged by their action at the glacier-foot. In periods of shrinkage of the ice, when melting has thoroughly set in, the intraglacial drift comes rapidly into prominence. "Stratified sands and gravels" are left behind in all the hollows; valleys are choked, and the striated floor and the *roches moutonnées* are concealed as quickly as they are deserted by the ice. In steeply falling valleys, it is unlikely that an esker-ridge would escape destruction during this final period of flood and flow. In open plains, however, the case is very different.

Let us picture Ireland in the Ice Age—a time of moderate coldness and abundant precipitation. The cold was sufficient to cause all the moisture to be deposited as snow; the precipitation was aided, moreover, by the greater height of the mountain-rim of the country, particularly on the western side. Above the town of Sligo at the present day, the Carboniferous Limestone rises in bold cliffs and plateaux; and the enormous quantity of limestone pebbles in the gravels of the plain shows that such high masses must have been common at the opening of the Glacial epoch. The plain itself was, however, determined by the synclinals of the Hercynian folding§; it had already assumed the character of a lowland, and was no doubt covered in part by swamps and pools, on

* "A Map to show the Distribution of Eskers in Ireland," *Sci. Trans. R. Dublin Soc.*, Vol. V. (1896), pp. 788 and 794.

† *Quart. Journ. Geol. Soc.*, Vol. XXXI. (1875), p. 99. *See* also "On Drift," *Geol. Mag.*, 1874, pp. 509 and 510.

* "The Great Ice Age," 3rd edition (1894), p. 170. *See* also 2nd edition (1877).

† *Thirteenth Ann. Report, U.S. Geol. Survey* (1892), pp. 65 and 81.

‡ "Glacial Geology of Spitzbergen," *Quart. Jour. Geol. Soc.*, Vol. LIV. (1898), pp. 211 and 222.

§ Knowledge, Vol. XXI., p. 78.

which little icebergs began to float. Here and there, the sea may have encroached upon it, bringing in marine shells, which became broken up and mingled with terrestrial gravels poured down from the glaciated hills.

The precipitation continued in excess. The lakes and pools froze over throughout the year, and were lost beneath the mantle of freshly-falling snow. On all sides, from the slopes of the Kerry ranges, from the broad back of Leinster, from the high cirques of Mayo and Connemara, and from limestone uplands now altogether lost to us, glaciers crept down, spreading out in terminal fan-like forms, and finally coalescing in the plain. When the plain itself became full of ice, minor details of surface would cease to exert an influence, and the great lines of ice-movement asked for by Mr. Close in his memorable paper* may have been set up across the lowlands. The old extension of land southward and westward, of which we have so much evidence, may easily have provided nooks and corners, particularly on its seaward border, in which the early elements of the Irish fauna and flora could find refuge from these rigours for a time.†

We are not now concerned with the climax of the Glacial epoch, about which so much has been written, and about which we know so little. It is of small moment, moreover, in considering our eskers, whether part of the striation of our rock-surfaces was due to the movement of floating ice,‡ or whether it must be ascribed to ice-sheets of the magnitude demanded by Prof. Jas. Geikie and Mr. Close. The eskers belong to the latest phase, and overlie the boulder-clays and gravels, about which controversy is so often raised. It is now almost impossible, at any rate, to suggest a marine origin for the eskers.

Prof. Sollas's map of the Irish plain, from Galway to Dublin, shows the distribution of eskers over a wide area;

Fig. 2.—The south-west slope of the Esker at Tymon Castle.

and he reasons carefully, from their knots and confluences, as to their resemblance to river-courses beneath ice. Similar evidence has been gathered, both from North America and Scandinavia; and Prof. Russell's* description of the Malaspina glacier supplies exactly what the followers of Hutton and of Lyell demand—an example of "causes now in action," capable of explaining the phenomena left us from the past.

The Malaspina glacier lies in south-east Alaska, between the watershed that forms the Canadian frontier and the Pacific. It is seventy miles wide, and twenty to twenty-five miles long from front to back—*i.e.*, its length, like

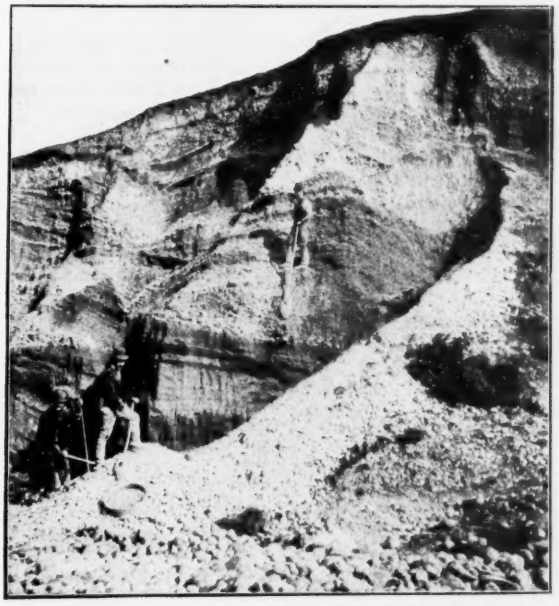

Fig. 3.—Section in the Esker at Green Hills, Co. Dublin, showing irregularly stratified gravels and purer sand below.

that of so many "hanging glaciers" in the Alps, is considerably less than its breadth. But it is not a hanging glacier, cut off in front along a line of cliffs; it results from the accumulation of snow and the confluence of normal glaciers, which slip from the mountain-ranges to the north; and it lies, with a fairly level surface, on "the flat lands between the base of the mountains and the sea." Hence it has been styled a "piedmont" glacier—an unfortunate term, when one thinks of the glaciers of Piedmont proper.

The moraine-material borne by it is covered with snow in the higher regions, and hence becomes "intraglacial." But it shows itself along the melting border of the ice, as a dark band some four to five miles wide. Forests of spruce firs and other vegetation, as shown in Prof. Russell's photographs, grow on this exposed material, which itself rests on the lower layers of glacier-ice. This dense woodland, rising from the surface of the glacier, is a fine example of the contemporaneous occurrence of a north-temperate flora and of continental ice. Animals similarly find a home on the ice, and their remains must become embedded in strata belonging to this local glacial epoch.

The area of the Malaspina glacier is one thousand five hundred square miles; but it is only fair to remember that it is fed by some of the highest ground in North America. Mount St. Elias, itself eighteen thousand feet in height, supplies it on the north-west through the Libby and the Newton glaciers.† The latitude of the district is sixty

* *Op. cit.*, pp. 231, 238, and Plate VIII.

† *See* Scharff, "Origin of European Fauna," *Proc. R. Irish Acad.*, 3rd Ser., Vol. IV. (1897); and comments by G. C. Carpenter, *Natural Science*, Vol. XI., pp. 382 and 385; and G. Cole, *Irish Naturalist*, 1897, p. 240.

‡ Garwood and Gregory, *op. cit.*, pp. 215 to 217; Scharff, *op. cit.*, p. 494.

* *Op. cit.*, p. 67.

† *See* Russell's Map *op. cit.*, Pl. IV.; and also Pls. V., VII., XV., etc.

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degrees north, about that of the Shetlands and Christiania. Could we procure a similar climate, *and similar means of precipitation*, along the west side of the Leinster Chain, a glacier as large as the Malaspina would cover all the lowland area of Kildare, Carlow, and Queen's County. Indeed, our highlands, as they now exist, would have gone far, at the close of the Glacial epoch, to keep the plain of Ireland full of ice.

Whatever the cause, the means of precipitation were actually provided; but at last the modern epoch opened. The sun shone on the ring of snow-peaks from Lough Foyle to Galtymore, on the long moor of Leinster, and on the white plateaux of the north; but centuries may have elapsed before the lowlands were free from the cold burden thrust upon them. The ice of the plain was full of intraglacial drift, shot into it by avalanches and landslides, or slowly incorporated with it by the glaciers descending from the hills. As melting began, this gravelly detritus would appear, capping, for instance, the islands of Clew Bay, or streaming down as delta-formations far out into the Irish Sea. Broad stratified deposits might be formed by a union of marine and river action; but in

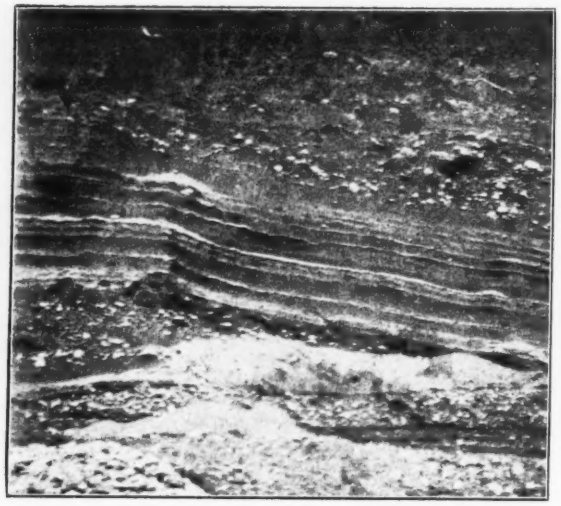

Fig. 4.—Stratification of Sand at base of the Green Hills Esker, Co. Dublin.

the interior of the country the deposits would be more hummocky and isolated, and would often represent the courses of the last subglacial streams. The plain of ice might in time become reduced to separate patches, each with its fringe of hillocks, piled up from intraglacial drift; and, where melting was slow and steady, true eskers might remain, sinuous and steep-sided, as casts of the more permanent waterways. For a long time, the torrential flow would have kept such channels open; so that the eskers represent the final accumulations, due to failure of the water-supply, and are younger than many of the distributed gravels, which originated equally from the intraglacial drift.

Such appears at present to be the logical history of eskers, like that of Balrothery and Crumlin. The stratification in the Green Hills of Co. Dublin is marked in the basal sands, but is highly irregular in the gravels of the summit (Figs. 3 and 4), and this is what might be expected from the suggested conditions of formation, the material having been washed down, at different times, with very different rates of flow. The freshness of the esker slopes, and the preservation of the ridge-like form, may be paralleled by the undisturbed outlines of the extinct scoria-cones of Auvergne. In both cases, the porosity of the material allows the water to sink through it, and a few channels here and there alone mark the attack of exceptional storms.*

We have, in conclusion, to go to the uplands of Tyrone to see what a part the "esker-drift" may play in the present conformation of the surface. Near Dunnamore, for instance, we may see a giant esker running across country, descending one side of the valley and climbing up the opposite slope, with all the persistent air of the Great Wall of China. In the hollow below us, the trend of which is scorned by it, the esker is breached by the existing stream. Clearly, its central part must have formed at one time the barrier of a temporary lake. When we ascend to the moorland over against us, we find the gravel ridge lost in a plexus of curving mounds, in the bays of which lakelets lie gleaming in the western light. As the sun sinks, the shafts pick out the soft green flanks of gravel domes, sometimes isolated, sometimes clustered in all manner of strange positions on the far hill-sides. Even on the high spurs of Slieve Gallion, Lough Fea is bordered by them, as if by the *débris* of a landslide. We look back along our grass-grown wall, the one side of which is now cold and purple-grey, the other golden in the sunset. It stands out before us more sharply than ever, still more strange and fascinating; and we feel that we have a good deal yet to learn with regard to the origin of eskers.

THE SEA-SQUIRT.

By E. Stenhouse, A.R.C.S., B.Sc.

THE sea-squirt has such a curious organisation, and passes through so strange a series of changes in its development, that it and its allies have long been regarded with more than usual interest by naturalists. For the sea-squirt is a living example of degeneracy, of structural degradation so complete that until recently it was universally supposed to be a mollusc. Its shape is roughly cylindrical or ovoid; its colour a dingy grey; and it lives attached by its base to a rock on the seashore. At its free end there is a hole, commonly surrounded by eight small lobes, and a little less than halfway down the side of the body is another opening, with six encircling lobes. The upper aperture is the mouth, and it leads to the digestive tube, which consists of a spacious pharynx immediately following the mouth, a gullet, a stomach, and an intestine. Completely surrounding the digestive tube, except along one line, where the pharynx is fused with the body-wall, is a chamber called the atrium. The atrium opens to the exterior at the lower of the two external apertures, which is hence called the atrial opening.

If the Ascidian be carefully watched under natural conditions, a current of water will be seen to continually enter the mouth and leave by the atrial opening. If it be touched the creature will suddenly send out a stream of water from each opening, and its common name is derived from this habit of squirting when irritated. The inflowing current of water is doubly useful to the Ascidian. It not only washes into the digestive canal the microscopic organisms which constitute its food, but it also carries in solution a store of fresh oxygen, which is just as necessary for the healthy life of the animal as it is for our own well-being. The region of the pharynx which is fused with

* *See* Judd, "Volcanoes," p. 155; Lyell, "Principles of Geology," Vol. II. (1833), p. 205.

the body-wall forms a mucous secretion, by which the food-particles are arrested and guided into the gullet, to undergo digestion in the stomach. The water, on the other hand, does not take this course, but passes through the tiny slits of the delicate basket-work composing the walls of the pharynx. The edges of these slits are beset by little lashing threads, known to biologists as cilia, and the result of their rhythmic motion is that a continuous current of water is driven from the cavity of the pharynx to the surrounding atrium. The slits in the pharynx-wall, arranged in transverse rows, are very numerous. Now, between each row of slits runs a little blood-vessel, and tiny branches also follow the delicate partitions between the slits themselves. The walls of the blood-vessels are excessively thin, and the oxygen contained in the sea-water is thus able to diffuse through the walls into the blood as the water swills through the slits. Waste carbon dioxide passes out from the blood into the water at the same time. Hence we have here all the essentials of a breathing-process.

The blood is constantly renewed by the beating of a little heart placed on one side of the stomach. The heart works in a somewhat peculiar fashion. The contractions are for some time in one direction, and then the motion is suddenly reversed, the blood being propelled in the opposite direction. In this manner does the adult creature live, if such an uneventful existence can be called living. It spends its days sedately rooted to the spot where, on abandoning the wayward habits of youth, it first settled down, and its obvious movements are limited to occasional contractions of the outer coat or "tunic." If the animal has any intelligence at all it is of the most rudimentary character, and it is even problematical whether it possesses any special sense-organs. There is a mass of nervous matter just at the beginning of the pharynx, and this and some neighbouring structures may be of use for testing the quality of the water flowing in at the mouth, but organs of sight and hearing are quite absent. The life of an oyster is in comparison one of pleasing variety.

It is one of the greatest triumphs of the still young science of embryology to have shown conclusively that this creature—little more than an automaton, and possessing no obvious trace of vertebrate structure—is yet a member of the great sub-kingdom to which all birds, mammals, reptiles, amphibians, and fishes belong, and of which we are pleased to consider ourselves the crowning pinnacle and glory. A brief *résumé* of the features which biologists consider to be essential characters of vertebrate animals may assist the reader to a better appreciation of the masterly piece of research by which Kowalewsky showed the Ascidian to be a fallen vertebrate, and gave to it a position of quite unique interest.

In the first place, all vertebrates possess a supporting skeletal rod running along the main axis of the body. This is usually the "backbone," but it may be represented by a spinal column of cartilage or gristle, as is the case with the sharks and their allies. In the lowest vertebrates, and in the embryos of all the higher ones, the skeletal axis consists of a simple continuous rod called the *notochord*, which is of the consistency of stiff jelly. Secondly, the central nervous system of all vertebrates arises as a groove along the middle line of the back or "dorsal" surface of the developing animal. The edges of the groove arch over and meet, converting it into a tube, which becomes the spinal cord and brain. Moreover—and this is a fact of very great interest to the evolutionist—every member of our great sub-kingdom passes through a stage in which the pharynx (already defined as the part of the digestive tube immediately following the mouth) has its side-walls perforated by slits. These gill-slits are present throughout the whole life of fishes. The water taken in at the mouth escapes through the slits, aërating the blood flowing through the gills on the margins of the slits as it does so. Amphibians, which nearly all spend their infancy in water, breathe during the greater part of their aquatic life exactly as do the fishes. When, however, the tadpole attains his froghood and leaves the water, his gill-slits close, and he breathes by lungs. This early habit of water-breathing probably indicates that frogs are descended from fish-like ancestors, and that the tadpole repeats, to some extent, his ancestral history in his own development, or, as Marshall happily expressed it, climbs up his own genealogical tree. Again, every bird and reptile, whilst in the egg, passes through a stage with gill-slits piercing the sides of the neck, slits which are of no conceivable use to it as organs of respiration, and which are only explicable as ancestral features which have persisted through countless ages.

It is clear, then, that no animal can justly claim the proud title of vertebrate unless it possess at some period of its existence (*a*) a notochord, (*b*) a dorsal tubular nervous system, (*c*) gill-slits in the wall of the pharynx; and Kowalewsky's famous research showed that the sea-squirt passes through a stage in which all three are present.

As he watched the tiny egg develop, he saw the single cell divide up until a hollow two-layered ball of cells was formed. The cavity of the ball, the primitive digestive sac, communicated with the exterior by a small pore. Next one side of the ball became flattened and then grooved. The groove was bounded by right and left folds, which soon began to arch over and unite at the hinder end. The union extended farther and farther forward on the dorsal surface until a tube was formed, the rudiment of the spinal cord and brain.

That a mollusc, as the sea-squirt was supposed to be, should develop a hollow nervous system in this manner was a very remarkable circumstance, and we can imagine with what breathless interest the observer must have watched the further growth of the little embryo. For what followed was stranger still. A rod of cells between the nerve-tube and the digestive sac became more and more prominent, and soon acquired all the characteristics of a veritable notochord. Then the hinder part of the embryo began to grow out as a tail, carrying both spinal cord and notochord with it. At the opposite end a mouth opened into the digestive tube, and the enlarged front end of the spinal cord developed an eye and an organ of hearing. The embryo was now a free-swimming larva, which was in appearance and structure curiously suggestive of a tadpole, but it was of very minute size. Openings soon perforated the walls of the pharynx-region, but the growth of an atrium round the pharynx shortly afterwards shut off these gill-slits from communicating directly with the exterior.

The tiny larva, which thus conformed completely with vertebrate requirements, swam about vigorously for a few hours by means of its fish-like tail-fin, and then—"O! what a fall was there!"—it fixed itself by some little suckers which had appeared under the mouth, the tail grew less and less, and eventually vanished altogether, taking notochord and spinal cord with it; the eye and the organ of hearing disappeared; and the front end of the nerve tube, too, so hopefully suggestive of a brain, dwindled until nothing remained but a little shapeless mass. Gone, "like the baseless fabric of a vision," were all vertebrate characters save a few poor gill-slits. These slits increased in number, various changes in the relative size of other organs occurred, and the animal stood revealed, a prosaic and phlegmatic sea-squirt.

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THE AFFINITIES OF FLOWERS.

THE BLADDERWORT AND ITS RELATIVES.

By Felix Oswald, B.A., B.Sc.

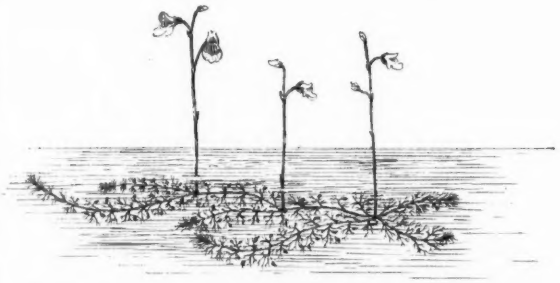
In wandering over some desolate moor in July or August, we may perchance find a peaty pool aglow with strange yellow flowers, somewhat like snapdragon, on slender stalks which rise from a green feathery mass floating just beneath the surface of the water. Let us lift out the whole plant and examine it more closely; we can then clearly see why it has been named the bladderwort, for we find numbers of minute pale-green bladders interspersed among the branching feathery leaves. Observation alone will lead us to infer that these little bladders are merely modified leaflets, for they are set on stalks arising from the much divided leaves, generally from a point of bifurcation. Moreover, they still bear branching bristles at the apex, similar to the leaf filaments. Some species indeed, (*e.g.*, *Utricularia intermedia* and *U. grafiana*), reach a further stage of specialization in having the bladders restricted to separate branches.

There is a total absence of roots, just as in many other floating plants, such as the water-fern (*Salvinia*). Indeed, the rootless condition has become so deeply impressed on the constitution of the bladderwort that not even a primary root is developed when the embryo germinates. The hair-like character of the leaves may perhaps be due to their having to adopt the function of roots in absorbing the nutrient salts contained in solution in the water. But it may be also due (as Grant Allen has suggested in regard to the submerged leaves of the water crowfoot) to the necessity for searching out, so to speak, for the scanty amount of carbonic acid in the still waters frequented by these plants.

The bladders, however, form the chief interest of this strange plant, for they have become differentiated into the most efficient traps for catching small water animals. The entrance to the bladder is firstly protected, by means of branched bristles, from larger creatures, which might damage the apparatus. When once past this *chevaux de frise*, an entrance is easily effected by pushing inwards the elastic valve or upper lip, which closes tightly upon the lower lip—a thickened cushion of tissue. But no return is possible when the door has closed, and all hope of freedom must be abandoned. Here the prisoners remain in their dungeon until they die from suffocation or inanition, victims to their own curiosity. Death usually overtakes them in about twenty-four hours, although they sometimes linger on for as long as six days. A close scrutiny of the bladders will usually reveal a variety of small crustaceans such as water fleas (*Daphnia*, *Cypris*, and *Cyclops*), larvæ of gnats and midges, innumerable infusoria and diatoms, and even small worms. The bladderwort, however, is not always left in undisputed possession of its prey, for a water spider sometimes finds it a profitable undertaking to spin its silken silvery bell among the branches of the plant, and to rifle the contents of the bladders.

No digestive ferment is secreted in these traps as on the leaves of the carnivorous sundew and butterwort, but we find special absorbent hairs arranged in groups of four, studded at intervals all over the inner surface of the bladder. A gradual transition may be observed between these peculiar hairs and those outside,* which secrete a kind of mucilage, perhaps attractive to the deluded visitors. It is considered probable that the nitrogenous products of decomposition are taken up by the internal hairs into the system of the plant for assimilation—a distinct advantage for the species, since peaty soils are well known to be deficient in nitrogen, which is so important an element of animal and plant life. It is also possible that the carbon dioxide exhaled by the animals during their imprisonment may be of considerable service to the plant.

On the approach of winter the whole plant decays, with the exception of the terminal bud, which is wrapped up and protected by leaves closely crowded together, but without any bladders. This resting bud eventually sinks to the bottom of the pool, just as the frog-bit (*Hydrocharis*) and many other water plants. The warmth of spring rouses the dormant bud into activity, the leaves expand, the stem grows, bladders are again developed in place of leaflets, and the plant rises to the surface of the water. Formerly it was considered that the sole reason for the existence of the bladders was to raise the plant from the bottom of the pool after the long winter rest, and to buoy it up so as to float in the most suitable position. It is possible, indeed,



Bladderwort plant in flower, one-third less than natural size.

that their primary function was hydrostatic, and that the habit of catching animals is secondary, and has induced several modifications in structure; yet it is clear that at the present time the bladders cannot act merely as buoys, in view of the fact that the small British *Utricularia intermedia* does not float at all, but creeps along the bottom of pools, anchored to the soft mud by the bladders, which, in this case, are borne on separate branches of the stem. Moreover, there are many purely terrestrial species of bladderwort in the tropics which possess bladders essentially similar to those of our aquatic species, although very much smaller. They frequent, however, damp places, in association with mosses and liverworts. A strange instance of dependence of one plant upon another is afforded by a Brazilian species (*Utricularia nelumbifolia*); it lives in the reservoirs of water formed by the leaf rosettes of *Tillandsia* plants (allies of the pineapple). This bladderwort spreads abundantly, sending out long runners which grope their way to another water receptacle of a *Tillandsia*, and even to those of neighbouring plants.

The bladderwort belongs to the small family Lentibulariaceæ, represented in Britain by only one other genus, viz., the insect-catching butterwort, which is not, however, a very close relative. The characteristics which they possess in common show a considerable degree of specialization; for instance, both calyx and corolla are irregular, with two broad lips, somewhat like a flattened snapdragon. The corolla is produced into a honey-containing spur; the stamens have become reduced to two; the ovary is unilocular (*i.e.*, it consists of a single chamber), with the ovules arranged on a central pillar; the fruit is a capsule

* Chodat has shown that these hairs arise from cells which in land-plants would have become stomata; a change of habitat necessitating a change of function.

opening by two valves; and the seeds contain no reserve material or endosperm.

The flower of the bladderwort is particularly remarkable for the extreme irritability and sensitiveness of its stigma; the two lobes close together immediately on being touched, but open again after two or three minutes if no pollen grains happen to be enclosed in their embrace. A precisely similar device is to be found in the yellow monkey-flower (*Mimulus luteus*) which is sometimes found floating in golden masses on still and silent pools. A flower-haunting fly, such as one of the hovering *Syrphidæ*, will alight on the lower lip of the corolla, and in thrusting his proboscis down the tube in order to reach the honey in the spur, will first of all rub his back against the stigmatic lobes which project beyond the anthers. Directly afterwards he will be dusted with fresh pollen and will be ready to carry it to the next flower he visits. The sensitive folding together of the stigmatic lobes is thus a safeguard against self-fertilization, for when the insect, laden with pollen, withdraws from the flower, the lobes will have their receptive surfaces in close contact with each other. Yet, if the flower is not fortunate enough to secure the advantages of cross-fertilization by insect agency, it will take to self-fertilization as a last resource, the stigma curling round backwards so as to receive the pollen which at first it was so careful to avoid.

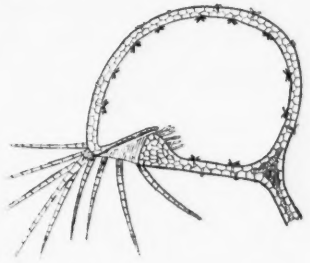
The butterwort (*Pinguicula*) is in some respects more highly specialized than its cousin the bladderwort—at least from a physiological point of view—for its leaves can not only catch insects with a greasy sticky secretion, but can also digest them (just as in the sundew) by means of the ferment pepsin. Moreover, the flowers of the butterwort reach a higher note in the scale of colour; *Pinguicula alpina*, indeed, is yellow, and is fertilized by flies (*Syrphidæ*), but *P. vulgaris* and *P. grandiflora* are deep blue and adapted for bees.*

The butterwort on the other hand is provided with roots, and still shows the primitive characteristic of a rosette of simple undivided leaves, of which only a trace exists in the youngest stage of the bladderwort, although this rosette is more noticeable in the terrestrial species. The stigma of the butterwort does not show any sensitiveness to the touch; its lower lobe merely hangs down like a curtain in front of the anthers so as to intercept any pollen which may be brought by a winged visitor. Self-fertilization, however, may likewise occur if no pollen has been transferred by insects from other flowers. Finally, the embryo of the butterwort has not reached quite so low a state of degeneracy as in the bladderwort, because it is still provided with a seed leaf.

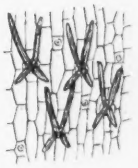
We have to turn to the tropics in order to find another member of the order, which will show intermediate characteristics between our bladderwort and butterwort. This is the genus *Genlisea* of Brazil, which retains the primary rosette of leaves; the stem is, however, thickly covered not only with unmodified spatulate leaves, but with others metamorphosed into curious insect traps, long-necked bladders with a kind of spiral entrance, thickly beset with hairs, pointing backwards and preventing any escape. *Genlisea* is a land plant, but agrees with the bladderwort in being destitute of roots.

The tropics, again, are the home of the Gesneriaceæ, the order with which the Lentibulariaceæ show the closest genetic relationship, for although the flowers possess external resemblances to some of the more distant Scrophulariaceæ, such as snapdragon and calceolaria, yet these similarities are no more than what all three orders possess in common.

The Gesneriaceæ form a family well known to gardeners for the handsome and showy flowers comprised within its limits, such as *Gesnera*, *Gloxinia*, *Achimenes*, *Æschynanthus*, etc.



1. Bladder of Bladderwort, in diagrammatic section, magnified.

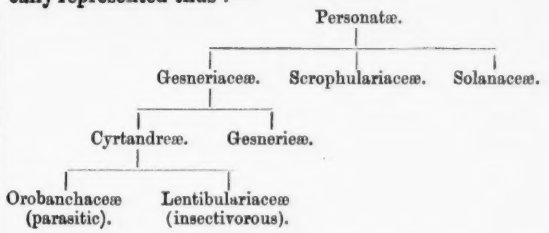


2. Internal absorptive hairs, still further magnified.

The Lentibulariaceæ possess so many points in common with the Gesneriaceæ, especially with the subdivision Cyrtandreæ that they might almost be classed with the latter; thus, in both cases the ovary is unilocular and the seeds are without endosperm. Moreover, many of the Cyrtandreæ have only two stamens, and the genus *Streptocarpus* agrees with *Utricularia* in the absence of even a primary root.

It may be added that the parasitic family of broomrapes (Orobanchaceæ) is also closely allied to the Gesneriaceæ, and agree, too, with the bladderwort in the embryo being totally undifferentiated, consisting merely of an oval cellular mass.

In conclusion, the different relationships may be graphically represented thus:—



ETHNOLOGY AT THE BRITISH MUSEUM.

By R. Lydekker.

SINCE, so far at least as his bodily structure is concerned, man evidently forms but the highest development of the mammalian type, it is evident in every well-arranged museum he should take his proper position at the head of the series, adjacent to the man-like apes. And it is therefore in the highest degree satisfactory that this has at length been recognized by the authorities of the natural history branch of the British Museum, where an ethnological series is now in process of formation and arrangement in the upper mammalian gallery. It is not, indeed, that this is an entirely new departure, for ever since the transference of the natural history collections from Bloomsbury to South Kensington, human skulls and skeletons were arranged in serial position in the gallery of osteology, which formerly occupied the whole of what is now the upper mammalian

* The small Lusitanian butterwort is, however, pale lilac in colour, and depends only on self-fertilization. This is, perhaps, a case of reversion from the blue flower fertilized by bees.

gallery. But no attempt was made to exhibit man's external bodily form in its numerous racial modifications; and the specimens of his bony skeleton, like most of those of his fellow mammals, were widely separated from the mounted skins of the apes and monkeys.

In the new arrangement, now drawing to approximate completion, of the mammalian galleries such skulls and skeletons as are exhibited to the public are placed in proper position among the mounted skins of ordinary mammals, and man accordingly heads the series of exhibits. Although the amount of case room devoted to illustrate the bodily structure of the numerous varieties of mankind is comparatively small when contrasted with that in the new ethnological gallery in the Paris Museum, it will probably prove sufficient to exhibit examples of all the leading types which are likely to prove of general public interest, and is not disproportionate to the space given to other groups of mammals. In Paris it appears to be the practice to exhibit every skull and skeleton in the collection to the public, whereas in the British Museum the rule is to show only a limited number of examples, most of which ought to illustrate some particular point or feature. And, although to the specialist the former plan may be, and probably is far more preferable, yet to the general public there can be little doubt that the latter arrangement is the more advantageous, since the exhibition of a large series of duplicates is much more likely to confuse than to instruct.

Bushman. From a Photograph of a Life-like Model in the British Museum.

That such an ethnographical series as is contemplated in the Natural History Museum will do much to educate the public on matters anthropological cannot for one moment be doubted, seeing that there is no other institution in London where a similar exhibition is displayed; and that, as a general rule, English people display a remarkable lack of information concerning the relationships and peculiarities of their fellow human races. With our vast colonial empire, we, of all people, ought to make mankind our especial study; and we ought to be in a position to make the national gallery of ethnology almost unique in its completeness, so far as the allotted limits of space permits.

In considering man from a purely zoological standpoint, as it is necessary to do in an exhibition of this nature, it is obviously imperative to take into consideration only his bodily form and structure, putting entirely on one side arts and manufactures of every description. To study the weapons and dress of modern aboriginal tribes, and the various implements of our prehistoric ancestors, the student may visit the British Museum at Bloomsbury, while he will find no inconsiderable series of specimens of prehistoric implements in the palæontological gallery of the branch establishment in the Cromwell Road. But, as has been well remarked, to form a complete anthropological series it is illogical in the extreme to stop at the implements, manufactures, and arts of savage and prehistoric tribes. Such a series ought to commence with the rudest drawings on mammoth ivory, and the most primitive stone weapons, and to conclude with a selection from the last Academy exhibition, and examples of Krupp and Maxim guns. But whether such a splendid collection will ever be realised or no, it does not really concern us here, and we may accordingly revert to the gallery in the museum.

For such a gallery the selection and proper arrangement of suitable objects is a matter of much greater difficulty than might at first be thought to be the case; while even when the nature of such exhibits has been decided, there is often immense difficulty in procuring the requisite specimens. In a gallery open to the general public of both sexes and all ages there are obvious objections to exhibiting models of the entire human form, and it has accordingly been decided that busts are the kind of model best adapted for display. At present the series of these is very small, but we believe that steps are being taken to augment it as rapidly as possible. Already several of these busts attract general public interest. Among these attention may specially be directed to those of a male and female Bushman and a Tasmanian man and woman, as exhibiting two very characteristic types of the inferior races of mankind. By kind permission of Sir W. H. Flower we are enabled to present our readers with photographic representations of two of these life-like models. To those of the Tasmanians an especial and mournful interest attaches, since they are taken from two of the last survivors of a very remarkable pure-bred race whose extermination was brought about by means reflecting but little credit on our own character as a nation. Unfortunately, the extermination of the Tasmanians took place before sufficient care had been taken to secure abundant examples of their skulls and skeletons, which are now of excessive rarity in collections; and the Museum is therefore to be congratulated on having lately secured a perfect male skeleton. It may be added that the extermination of the Tasmanian serves as a warning that no efforts should be spared to obtain specimens illustrating the bodily structure of other primitive aboriginal tribes while there is yet time, since it is but too apparent that many of these, even in spite of strenuous efforts for their preservation, are doomed ere long to pass away for ever. Possibly, too, in the years to come, when education has advanced its sway over a still wider circle, the survival of such races in their primitive form may even be regarded as a blot upon the world's civilization, so that efforts may be made to "improve" the survivors out of existence.

After models, the next best method of showing the racial variations of man's external form is by photographs. For the most part those exhibited in the Museum comprise only the head and neck, and, where practicable, these are enlarged to the natural size. These large-sized photographs have been executed in platinotype under the immediate superintendence of Mr. H. O. Forbes, the Director of the Museum at Liverpool. At present the series is richest in North American Indians and African Negroes, but there are also numerous examples of Melanesians and Papuans. As an example, a reduced reproduction of the photograph of a Papuan girl, exhibiting

in great perfection the artificial frizzing-out of the hair, is herewith given. And it may be mentioned that in the case of tribes who are in the habit of thus dressing their locks, photographs have a decided advantage over busts, in which it is impossible to reproduce the peculiar style of capillary adornment.

As regards the exhibition of human skulls and skeletons, it must be freely confessed that in a public museum these have, at least at first sight, a somewhat gruesome and

Tasmanian Woman. From a Photograph of a Life-like Model in the British Museum.

ghastly effect. Nevertheless, this is to a very great extent undoubtedly due to early associations and prejudices; and if we can but disabuse ourselves of these, such objects are really very far from being repulsive, especially if artistically arranged among the busts and photographs, and not occupying the whole of the shelves to themselves. Apart from all such considerations, the exhibition of parts of man's anatomy is, however, of primary importance in the formation of an ethnological gallery, seeing that many of the most important racial characteristics are displayed solely by the skull and skeleton. Moreover, in order rightly to appreciate the marked cranial peculiarities distinguishing even the lowest representatives of the human race so broadly from the highest of the man-like apes, it is essential that a large series of the skulls of both should be on view.

Although there is still some difference of opinion among anthropologists as to the number of primary branches into which the existing members of the human race should be divided, in the arrangement adopted in the Museum only three such branches are recognised. These are (1) the Negroid, or black branch; (2) the Mongolian, or yellow and red branch; and (3) the Caucasian, or white branch. Wherever and whenever these three branches first originated, they are now so intermixed in many parts of the world by crossing, that it is frequently difficult to decide to which certain races belong, and it is consequently in some instances impossible to draw a hard and fast line between them. Nevertheless, the typical representatives of each show very distinct modifications. Although the colour of the skin forms one of the most marked points of distinction between such typical representatives, it must not be inferred that this character will hold good for all the races included under each. The Sudanis, for instance, many of whom are included in the Caucasian branch, are often as black as the Negroes, partly no doubt owing to a large infusion of Negro blood.

To give all the characteristics of each of the three primary existing branches of mankind, and to enumerate all the different races included in each, would obviously be far beyond the scope of an article like the present, and only a few of such points can be touched upon.

The Negroid branch is obviously the lowest of the three, as is exemplified by the projecting jaws, everted lips, and the flat and broad nose, supported by flattened nasal bones quite unlike the arched form which they assume in the Caucasian branch. It is in this branch alone that the so-called "woolly," or more correctly, "frizzly" hair is met with; the frizzly nature being due to each individual hair being elliptical instead of circular in cross section, and thus tending to twist on its own axis. But this frizzly character of the hair is not common to all members of the Negroid branch, being absent, for example, in the Australians, although present in their near neighbours the Tasmanians. And it is an interesting question to determine whether the frizzly or the ordinary cylindrical hair is the more primitive type; a question closely connected with the primitive coloration of the skin in the human race—whether black, yellow, or red. Some authorities, Monsieur de Salles for example, have attributed red hair to the earliest representatives of the human race; which would apparently imply also a light-coloured skin, although red hair and a leaden skin are associated in the Orang-utan. Again, M. de Quatrefages urges that nothing authorizes us to regard the Negroid branch as having preceded either of the other two, and further suggests that the ancestors of the modern Negro were of a much lighter colour than their present representatives.

Of course this is just one of those questions about which reams of paper might be written over without hope of a definite conclusion. But it may be mentioned that all anthropologists without exception recognize the projecting jaws of Negroes as a primitive feature, and, secondly, that the chimpanzee and gorilla, which come nearest of all the apes to the human race, have black hair and skin. Consequently, the onus of proving that the projecting jaws and other primitive features met with in modern negroes were ever associated with light-coloured skins and fair hair rests with those who are objectors to what may be termed the black theory of the human race. With regard to the frizzly hair of so many representatives of the Negroid stock, it is quite possible that this may be an acquired feature, seeing that it is much more probable the hair of primitive man was cylindrical, like that of apes, rather than elliptical. And if this be so, the Australians would seem to indicate a more primitive race than the Tasmanians.

The Negroid branch includes the typical Negroes of Africa south of the northern tropic, the pygmy Negrillos of equatorial Africa, the somewhat larger but equally primitive Negritos of the Andaman Islands and certain other parts of Asia, and also the great group of Melanesian or Oceanic Negroes, among which are comprised the Papuans of New Guinea, and most of the inhabitants of the smaller islands of the western Pacific, such as New Zealand, New Britain, New Caledonia, the Solomons, the New Hebrides, Fiji, etc. The native Australians and Tasmanians likewise pertain to this branch.

The true Negroes of Africa are the typical representatives of this branch, and present its most character-

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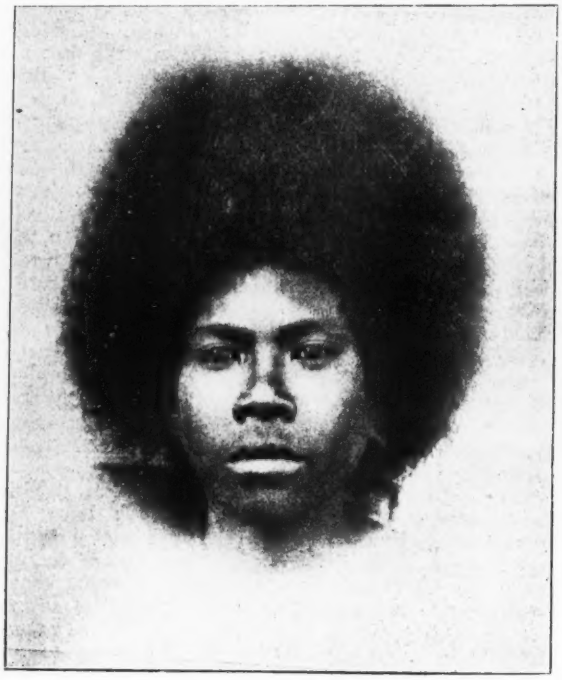
istic features, including the frizzly hair. All such Negroes are characterized by the elongated form of the skull, and the slight development of the ridges above the eyes, so that the lower part of the forehead is comparatively flat and smooth. The Negrillos of equatorial Africa are best known by the pygmy Akkas, so well described by Schweinfurth and Emin Pasha; one of the most valuable objects in the ethnological series of the Museum being the skeleton of an Akka woman, collected by the explorer last named. These Negrillos, like the Negritos of Asia, differ from the typical African Negroes, not only by their greatly inferior stature, but likewise by the shorter and more rounded form of their skulls.

The Oceanic or Melanesian Negroes chiefly differ from their African cousins by the much greater development of the ridges on the forehead of the skull above the sockets



Head of Papuan Girl, showing the artificial frizzing out of the hair. From a Photograph in the British Museum.

of the eyes in the male sex. The nose also is less wide and depressed, this feature displaying itself more distinctly as we approach New Guinea and the neighbouring islands. The culmination of this is displayed by the Maories of New Zealand, whose features are so Caucasian-like that some authorities have not hesitated to pronounce these people, to a large extent at least, of Caucasian origin. Their traditions, however, all point to a Melanesian origin. The custom of preserving heads with the skin attached among the Maories, renders specimens readily procurable for exhibition; although, for purely zoological purposes the tatooing is a sad disfigurement, the examples in which this so-called ornamentation is of the simplest character being consequently the most valuable in a series like that of the Museum.

The other two branches can receive but very brief mention here. In the Mongolian, or yellow and red branch, are comprised the typical Mongols of Asia, such as the Chinese, Tibetans, Tartars, Japanese, etc.; but to the same great branch belong also most of the inhabitants of Siberia, the Eskimo, the Malays, and the so-called brown Polynesians of the eastern Pacific, although, among both the two latter, there are often more or less pronounced indications of an admixture of Negro blood.

The Finns and Lapps derive their peculiar characters from a cross of Mongol blood with that of the dark Caucasian type. Although by some writers the aboriginal inhabitants of America previous to the immigration of white races from Europe have been regarded as indicating a fourth primitive branch of mankind, the general concensus of opinion points to the propriety of including them in the Mongolian group. And it is especially noteworthy that, as we pass eastwards in Northern Asia in the direction of Bering Sea, the native tribes assume a more and more marked approximation to the native American type. The general Mongolian type of countenance is too well known to require particular description; the yellow leathery skin, the prominent cheek-bones, oblique eyes, long straight hair on the scalp, and the slight development of hair elsewhere, being among the most conspicuous. American Indians have a redder tint of skin. Curiously enough, the Ainos, or primitive inhabitants of Japan, many of whom still remain in Yezo, differ from this type by their excessive hairiness, in consequence of which it has been thought that they are of Caucasian rather than Mongolian origin.

Of the Caucasians, or inhabitants of Europe, South-western Asia, and Northern Africa, it must suffice to say that they may be divided into a blonde, or xanthochroic, and a dark, or melanochroic type; the former being found in Scotland, Scandinavia, Northern Germany and Afghanistan; while the latter embraces the inhabitants of Southern Europe, the higher races of India, and many of those of North Africa, where, however, there is a large infusion of Negro blood. The Semitic (Arab) and Hamitic (Egyptian and Jews) races are wholly Melanochroi, but the Aryans belong in part to the Xanthochroi and in part to the Melanochroi.

Did space permit, this article might be extended to an indefinite length; but it is hoped that what has been written may suffice to awaken an interest among the readers of Knowledge in the efforts now being made by the British Museum to establish an ethnological series worthy of the nation to which it belongs.

THE FOURTH INTERNATIONAL CONGRESS OF ZOOLOGY.

CAMBRIDGE, 1898.

THE First International Congress of Zoology was held at Paris in 1889, under the presidency of Prof. Milne-Edwards. The second, which was held at Moscow in 1892, was presided over by Count Kapnist. The third took place at Leyden in 1895, Dr. Jentink being the president.

The Fourth Congress opened on August 23rd, 1898, under the presidency of the Right Hon. Sir John Lubbock, Bart., M.P., at Cambridge, a place eminently suited for such a Congress, both on account of its historical associations, and as the seat of a great zoological school.

The University and the Corporation gave the members of the Congress a most hospitable reception, and every comfort and convenience was provided for the large and representative gathering.

Tuesday, August 23rd.

In his Presidential Address, Sir John Lubbock expressed his profound regret at the absence of Sir William Flower,

who had been nominated President, but had found himself unable to accept the post owing to continued ill-health.

In the afternoon, in Section A (General Zoology), among others Prof. Mitsukuri, of Tokyo, read a paper "On some zoological matters in Japan." He traced the gradual rise of science in Japan from beginnings which could be traced back as far as the ninth century. He then gave a sketch of the present condition of zoological science in Japan, referring amongst other points of interest to the beautiful new marine zoological station at Misaki, near Tokyo, and to the great richness of the marine fauna of the neighbourhood.

Mr. Stanley Gardiner read a paper on "The building of atolls," suggesting that the depths at which corals and nullipores live is due to the extent to which light can penetrate sea water, the food of corals being derived entirely from the commensal algæ. The atoll-reef was then shown to have arisen from a pinnacle on the top of a dome-shaped mound, formed on an elevation of the ocean floor, which had been built up by the remains of deep sea animals. It was then urged that these pinnacles broaden by the addition to their edges of buttresses, etc., on a talus slope supplemented by the solution of their interior parts.

Wednesday, August 24th.

A general meeting of the Congress was held in the morning (Prof. Dr. F. E. Schulze in the chair), when Prof. Yves Delage opened a discussion on the position of sponges in the animal kingdom. The discussion was continued by Mr. E. A. Minchin, who remarked that there was no group of organisms whose systematic position is so much disputed, at all periods as well as at the present day. Up to the end of the first half of the nineteenth century it was still a matter of dispute if sponges were plants or animals; this controversy was laid to rest by the discovery of cilia by Dujardin (1841), and Dobie (1850), as well as by the subsequent researches of Lieberkühn and Carter. The animal nature of sponges was thus established, but their position in the animal kingdom was still uncertain. In conclusion, Mr. Minchin said that the larval development showed that sponges could not be considered Cœlenterates. Such a comparison must start either from the larvæ or the adults. If based on the larvæ, then neither the architecture nor the composition of the adults were in any way comparable. If based on the adult structure, then the larval development of sponges was altogether anomalous, and not similar to any other known development, since the ectoderm assumed an internal position, and became surrounded by the endoderm. The most probable view was that sponges were descended from Choano-flagellate Protozoa, since collar cells were not known to exist except in these groups.

The discussion was continued by Prof. Haeckel, who was in favour of the Cœlenterate theory; Dr. Vosmaer, who believed that "we cannot yet answer the question about the position of sponges," but suggested that "if we have to classify, we must either bring them to a separate group of the same value as the Metazoa, or consider them as Metazoa, but forming a separate class, like Cœlenterates, Echinoderms, etc."; Mr. Saville Kent, who urged that "this vexed problem of sponge affinities should be fairly approached and examined from a protozoic as well as from a cœlenterate basis, and that those undertaking the task should familiarise themselves with both the collar-bearing flagellates and the corresponding sponge elements in their living state."

In the afternoon Prof. Ewart exhibited and made remarks upon a very interesting series of slides, showing photographs of Hybrids between the Horse and the Somali Zebra.

Mr. Durham, for Prof. Kanthack and himself, read a paper on Tsetse Disease.

Tsetse disease, or N'gana, is one of the many scourges of South Africa. Bruce discovered that the cause of the disease is a parasite belonging to the flagellated protozoa and the genus *Trypanosoma*. According to Bruce's observation, the fly merely acts as a carrier. If it feeds on the blood of an infected animal, and again feeds within two or three days upon a healthy susceptible animal, it communicates the disease. A fact of importance in the dissemination of the disease is Bruce's discovery that the fly is viviparous; the mother flies have to feed frequently in order to nourish their young. Bruce has further shown that the blood of certain of the wild animals of the "fly districts" may contain the parasite (*e.g.*, the Koodoo).

At the instance of the Royal Society, the living parasite was brought over to this country, where a large number of experiments have been made.

The inoculation with the parasite not only gives rise to a fatal issue in the horse, ass, ox, goat, dog, and such domesticated animals, but is also fatal to mice, rats, etc., including the hedgehog. The guinea-pig is able to withstand the infection for several months in some cases.

So far we have no means of curing the disease when it has once begun, nor have we any means of preventive inoculation or salting. Some drugs, like arsenic, help to prolong the life of the animals, but the end is always fatal. Prof. Cossar Ewart has, with the true scientific spirit, allowed certain of his valuable zebra hybrids to be inoculated with the tsetse disease in order to see whether they will show a degree of refractoriness which the zebra must possess, in that it is capable of living in the fly-infested districts. It is too early to make any statement with regard to these animals, since they have only been recently inoculated. They have all shown signs of illness, and the parasite has been found in their blood. Whether they recover eventually must be left to the future to decide.

A question was asked as to whether man was refractory, in reply to which Mr. Durham said that all the evidence that we have in regard to the susceptibility of man is entirely negative. Man is bitten by the fly, and accidental scratches and cuts have been incurred during experimental investigation, which would have been sufficient to have communicated disease had man been susceptible.

Prof. Pelseneer, of the University of Ghent, expressed his views on uniform orientation of the figures in zoological papers, showing of what great advantage it would be if, in papers treating on the same objects, all the figures could be arranged in the same way, the left side of the animal, for instance, being always on the left side of the figure, and the same abbreviations being used for the same organs.

Thursday, August 25th.

An interesting discussion was held in the morning on the "Origin of Mammals." The debate was opened by Prof. Seeley (London) and Prof. Osborn (New York).

Prof. Seeley showed that the Theriodont division of the Anomodonts approached the mammalia in the characters of the teeth and the very small size of the quadrate bone; while, on the other hand, they suggested affinities with the Labyrinthodont reptiles in the presence of such cranial bones as the supratemporal, and of intercentra in the vertebræ. Although the parts of the pectoral and pelvic girdles bore a close comparison with those of the Monotremes, and although in many Theriodonts the skull was typically mammalian in form, the mandibular ramus never consisted of a single piece as in mammals. The Anomodonts were not the parents of mammals, but a collateral and closely related group; and the common parent of both

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might be sought in rocks older than the Permian, perhaps in Silurian or Devonian strata.

Prof. Osborn said that in order to clear the way for a successful attack upon the difficult problem of the origin of mammals, it was necessary first to reject the hypothesis, brilliantly formulated by Huxley in 1880, of a genetic succession between Monotreme, Marsupial, and Placental types, since neither palæontology nor comparative anatomy supported this view. He concluded by saying that for further developments of the problem we must probably look to the rich fauna of the Karoo beds of South Africa.

A discussion followed, in which Profs. Marsh, Haeckel, Adam Sedgwick, Hubrecht, and Newton took part.

In the afternoon in the Senate House, the honorary degree of Doctor of Science was conferred on the following:—H. P. Bowditch, A. Dohrn, A. Milne-Edwards, C. Golgi, E. Haeckel, A. A. W. Hubrecht, H. Kronecker, W. Kühne, and S. J. Marey.

Dr. Sandys, the Public Orator, in the speeches in which he introduced the above-named, adopted the reformed pronunciation of Latin, which was greatly appreciated by the large number of International visitors in the Senate House.

We have not space here to print the speeches *in extenso*.

Dr. Sandys referred, amongst the zoologists, to Prof. Milne-Edwards as not only the first president of such gatherings as these, but even their instigator and parent.

Prof. Haeckel was referred to as not only an indefatigable investigator of the minute forms of marine animal life, but also as a daring propounder of an imposing theory, throughout which he had endeavoured to trace the origin of animal life from its remotest source.

Prof. Hubrecht was introduced as a man who, born among the Batavian fields, and gifted with the happiest of dispositions, has won the hearts of all. There is scarcely a nation in Europe whose language he has not claimed for his own; added to this, he has collected for accurate investigation those most minute and microscopic sea monsters (if I may use the expression) which are designated Nemertea. If we may believe the Greek poets, those great beasts are, at all events, sufficiently ancient in origin and worthy of notice. I need hardly say, that Nereus himself was *νημερτής τε καὶ ἤπιος* (truthful and gentle), while Proteus, *γέρων ἅλιος νημερτής*, "The old man of the sea who never told a lie." However this may be, in extolling a man by whom those marine monsters in all the various forms they assume have been most veraciously described, nothing is easier than to speak the truth, nothing pleasanter than (to quote Homer) *νημερτέα μυθήσασθαι*.

Friday, August 26th.

Prof. Haeckel read an extremely interesting paper on "The Descent of Man." He said that the monophyletic origin of all mammalia from the Monotremata upwards to Man is at present no more a vague hypothesis, but a positively established fact. All the living and extinct mammalia which we know are descended from one single ancestral form, which lived in the Triassic or Permian period; and this form must be derived from some Permian, or perhaps Carboniferous, reptile (allied to the Progonosauria and Theriodontia), and the latter from a Carboniferous amphibian (Stegocephalia). These latter are descended from Devonian fishes, and these again from lower vertebrates. Much more difficult is the question of the origin of the great vertebrate-stem, and its descent from invertebrates. But these questions are not so important as the fact that Man is a member of the primate-order (Linné), and that all primates descend from one common stem (Huxley). Zoology may be proud to have proved this fact, based on the theories of Lamarck (1809) and of Darwin (1859).

Several other papers were read during the day, amongst which was one by Sir Herbert Maxwell on "Recent Legislation on Protection of Wild Birds in Great Britain," in the course of which he pointed out the necessity of international protection as the only efficient safeguard against the diminution of a great many of our migratory birds.

On Saturday morning, August 27th, a general meeting was held, at which it was decided that the fifth Congress should be held in Germany in 1901. The members of the Congress then adjourned to London, to attend a reception by the President and Council of the Zoological Society at the gardens in the afternoon and a reception by Sir John Lubbock at the Natural History Museum in the evening.

On Monday a good number availed themselves of the Hon. Walter Rothschild's invitation, and spent an enjoyable and profitable day at Tring.

On Tuesday about forty members of the Congress journeyed to Woburn Abbey, at the invitation of His Grace the Duke of Bedford, and spent a delightful day in inspecting his magnificent collection of deer, yaks, zebras, and other wild animals.

THE GREAT SUNSPOT AND THE AURORA.

By E. Walter Maunder, F.R.A.S.

It is almost two years since the occurrence of a most remarkable sunspot, a series of photographs of which were published as the astronomical plate in Knowledge for November, 1896. That group was remarkable as being the longest connected stream of spots observed on the sun during the present quarter of a century. It was no less remarkable that so great an outburst should take place at a time when the mean solar activity had already much declined. Three years had passed since the maximum, and in the ordinary course the minimum was expected in four years more. Since then the further decline in the solar activity has been marked enough. The number of days on which the sun has been wholly free from spots has increased rapidly, and yet now, as if on purpose to entirely upset all our conceptions, we have a fresh solar storm on a scale that would be noteworthy even at the time of full maximum, two years after the group we have just referred to, five years after the maximum, and when, according to rule, we have barely two more years to wait for the minimum.

Our present group was one of an entirely different order to that of two years ago. It probably might have been observed as a notch on the limb of the sun on the afternoon of Friday, September 2nd. By the following morning it was well within the limb, a single large spot, of area of nearly one thousand four hundred millions of square miles, with dark nucleus, and lying amongst long ridges of bright faculæ. By Sunday, September 4th, it was sufficiently advanced on the disc to show some of its peculiar beauties with distinctness. The details which perhaps drew most attention were the long tongues of bright matter which invaded the spot from without. The northern edge of the principal umbra, which was very dark, was fringed with such tongues, and a brilliant one invaded it on the south preceding side. This latter tongue had adopted a most curious form by the following day. A double spear of light pierced the darkness of the umbra to its centre, and was then bent obliquely backwards. On this day, Monday, the first elements of a following stream of spots were seen, which increased rapidly day by day up to the 10th, grouping themselves on the 8th and 9th, principally in two very complex clusters. Wednesday, September 7th, showed a great increase in the following spots, and the bright photospheric matter appeared mixed

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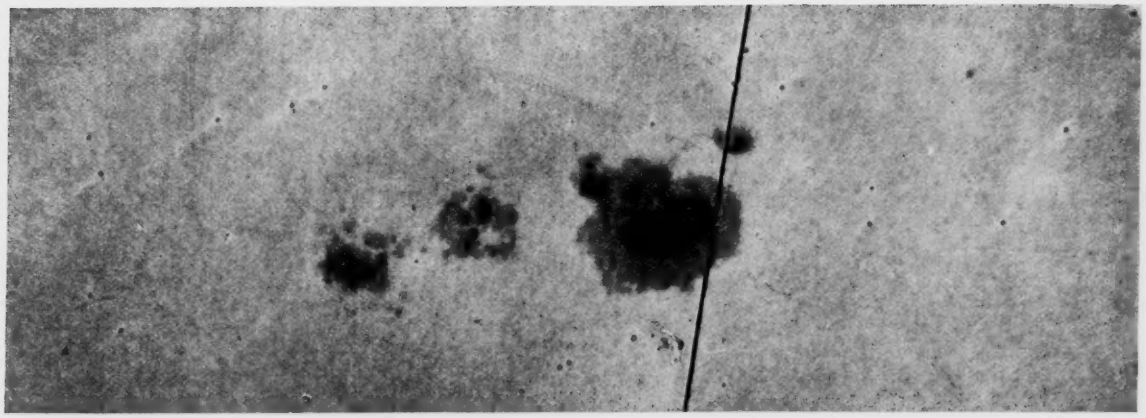
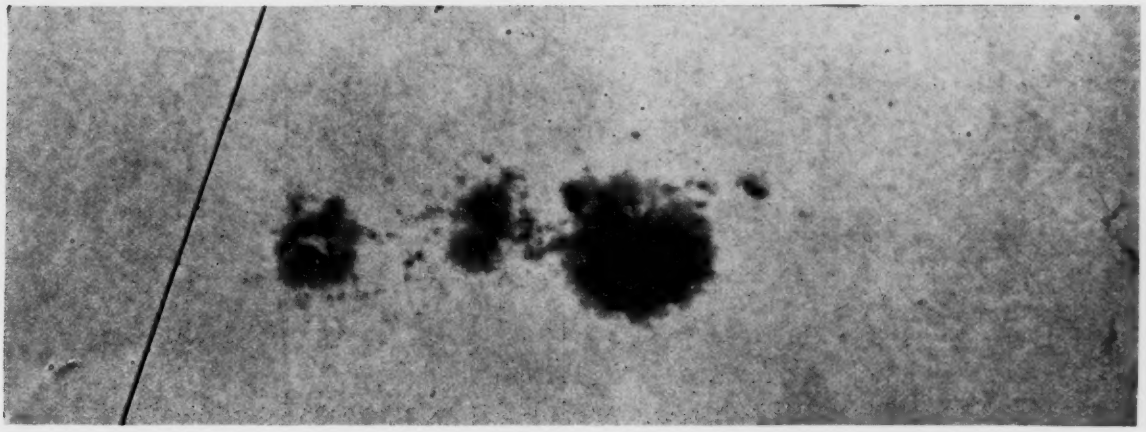
NORTH.

1.



EAST. 2. WEST.



3.

THE GREAT GROUP OF SUNSPOTS of September 3rd—15th, 1898.

As Photographed at the Royal Observatory, Greenwich.

1. Taken 1898, September, 8d. 10h. 29m. 19s. Greenwich Civil Time.
2. „ „ 9d. 14h. 59m. 2s. „ „ „
3. „ „ 10d. 10h. 40m. 6s. „ „ „

(Reproduced by permission of the Astronomer Royal.)

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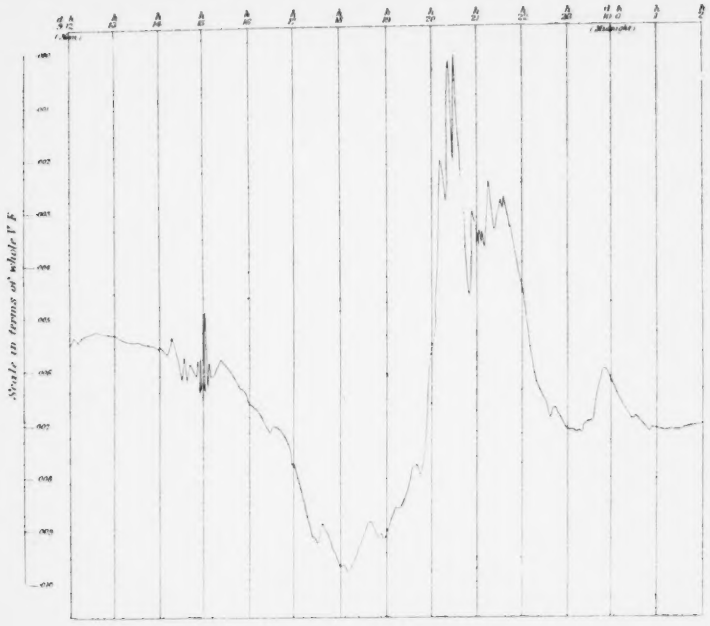
with the northern portion of the great spot, in an intricate lacework of light on the two next days. By the 11th the middle spots in the following stream had begun to disappear, and by the 13th only one small dot remained in that part of the group, the rearward spot being then separated from its leader by a broad belt of photosphere. By this day a very fine bright bridge, which was in process of formation on the previous day, had forced its way across the great umbra from north to south. The northern portion of the great spot was still full of complicated detail. On the following day the bright tongues which invaded the spot lay mostly on the east. By September 15th the great spot was seen only as a notch on the limb, and one spot alone followed it.



Tracing of Vertical Force Photographic Register during the Magnetic Disturbance of 1898, September 9—10.

The accompanying plate shows the group at its fullest presentation, namely on September 8th, before it had reached the central meridian, and September 9th and 10th, immediately after passing it. These were the days, too, on which it attained its greatest area and extent; the total area of the group being then some two thousand seven hundred millions of square miles, its greatest length nearly one hundred and forty thousand miles, and its breadth forty-four thousand miles. They are reproduced, by the kind permission of the Astronomer Royal, from photographs taken in the ordinary routine at the Royal Observatory, Greenwich, with the photoheliograph presented by Sir Henry Thompson. This instrument has an aperture of nine inches, stopped down to four inches on the present occasion, and a focal length of eight and a-half feet. The image in the primary focus is about one inch in diameter, and is enlarged by a secondary magnifier seven and a-quarter times. The resulting photograph has been further enlarged some two and a-half diameters, so that the present plate gives the spot on a scale of eighteen inches to the sun's diameter.

A special interest attaches to a great disturbance like the present when it occurs at a normally quiet time, for it brings out into clearer relief the peculiarities of the connection between these solar displays and the related phenomena on this planet of magnetic storms and auroræ. The accompanying trace, reproduced from the photographic sheet of the vertical force magnet at Greenwich, shows that some fourteen hours after the great spot crossed the central meridian of the sun, a sharp magnetic disturbance set in, which was at its height from eight to eleven o'clock on Friday evening, September 9th.

During these three hours an aurora of a specially brilliant and beautiful character was observed generally throughout the British Isles, the official report of the Greenwich observer, Mr. Beadle, running as follows:—

"At 20h. 45m. a bright light was observed in the northern sky from which issued several white streamers. These became especially distinct at 21h. (when they attained an altitude of about 45 degrees), and remained visible, more or less brightly, till about 21½h.

"By 22h. an arch had formed. This was of bright yellow light and the ends were separated by a distance of about 90 degrees; it was most decided in form and colour at about 23h. 15m. At this time the summit of the arch was fifteen degrees to twenty degrees above the horizon. By 23¾h. the phenomenon had quite disappeared."

A fainter display was noticed also the following night, and in more northern latitudes, as in Norway, the auroræ were most brilliant for several successive nights.

It will be noticed that we have here, again, a striking case of the quick answer of the earth to a really great solar disturbance, of which I gave several instances in my paper on "The great Sunspot and its influence," in Knowledge for May, 1892, and that the terrestrial disturbance was at its height about twenty or twenty-one hours after the sunspot had reached the centre of the disc. My own experience fully confirms that of Signor Ricco, the great Italian solar observer, that this is the relationship that most generally prevails. Dr. Veeder, on the other hand, considers that the influential position for a sunspot is when it is on the east limb, a view in which I am not able to coincide. A spot like the present occurring at a comparatively quiet time is even more useful for settling such a point than one at maximum.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE AURORA BOREALIS.

To the Editors of Knowledge.

Sirs,—As I was particularly well placed for watching the very fine Aurora Borealis on the evening of the 9th inst., I think you may possibly find some interest in comparing my observations with those of others.

I went out in the garden just after 8 o'clock, and was immediately struck by curious flecks of light in the south, suggesting luminous clouds, and on going out on to Bramshott Common, where there is an uninterrupted view for many miles, I saw that in the north there was a pale yellowish-white light, which gradually increased in

brilliancy. Meanwhile little gauze-like clouds in the south and south-west caught gleams of light, flickered, and quickly faded again.

About 8.30 bright shafts of light began to shoot up from the northern horizon, and from then until past 9 o'clock there was an almost continuous display, increasing and diminishing in brilliancy alternately.

Magnificent great rays, like columns of light, shot up far into the sky, some reaching as high as the pole star or even higher. There were three, four, five, and at one time, seven of these shafts, extending westward nearly to Arcturus and eastward occasionally as far as Capella. Those near the centre were of a pure, clear, white, while those on either side took a decidedly rosy-pink shade, and were not so clearly defined at the edges. A friend who was with me saw exactly the same difference in colour which I noticed.

After 9 o'clock the display gradually ceased, but the light was still lingering in the north-eastern sky at 11.30.

I may mention that at 8.40 I could see the time by my watch easily and distinctly, but at 9 o'clock I could only with difficulty distinguish the position of the hands.

Bramshott Common, Surrey, J. M-R.
Sept. 12th, 1898.

Erratum.—In Mr. Saxby's article, in the August number, on "How to Photograph through a Fly's Eye," at page 188, column 1, line 6, for "The cornea, hyaline in shape," read "The cornea is hyaline."

Science Notes.

Sir William Crookes may possibly have sounded the alarm a little prematurely with respect to a pending universal wheat famine, and that "starvation must be averted by the laboratory." While it is a fact that at present the United Kingdom grows only twenty-five per cent. and imports seventy-five per cent. of its annual consumption of wheat, it is also true that ours is one of the best wheat producing countries in the world—the yield per acre for the United Kingdom being 29·1 bushels, whereas in the United States it is 12 bushels, in Russia 8·6 bushels, and in Australasia only 6·8 bushels, the average of the whole world being 12·7 bushels. Anent the argument that by increasing the present average wheat crop per acre from 12·7 to 20 bushels in order that the world's supply may keep pace with the demand, we refer our readers to the results of the Rothamsted agricultural experiments.* There it will be seen that in 1863, with the aid of mixed mineral manure and nitrate of soda, 55⅝ bushels per acre were grown on land which is not better than the average as regards natural fertility. Sir William's presentiment of coming evil, though well-founded, need not therefore alarm us if the cultivators of the soil will only follow the example of those pioneers who have elicited so much from the economy of Nature.

Professor Japp, in his Presidential Address on "Stereochemistry and Vitalism" before the Chemical Section of the British Association, attacks the question whether the phenomena of life are wholly explicable in terms of physics and chemistry. The frank admission which he makes, coming as it does from so great an authority on organic chemistry, will be received with satisfaction by those who do not regard science as the *alpha* and *omega* of opinion on this much controverted question. He says: "I see no escape from the conclusion that at the moment when life first arose a directive force came into play—a force of precisely the same character as that which enables the intelligent operator, by the exercise of his will, to select one crystallized enantimorph and reject its asymmetric opposite. I would emphasize the fact that the operation of a directive force does not involve a violation of the conservation of energy."

M. de Rougemont's ordeal before the British Association is reminiscent of other travellers who have brought home strange stories of adventure in unknown lands. Bruce was for some time regarded as a romancer, M. du Chaillu was suspected as a perverter of the truth when he disclosed his story of the gorillas, and even Mr. Stanley was, like Joseph, believed by many to be a dreamer when news came of the finding of Livingstone. Certainly the desirable credentials to establish the truth of the traveller's story are still wanting, but the ready, straightforward and ungarnished narrative goes a good way to dispel doubts as to the veracity of the forced exile. Much that M. de Rougemont had to tell is merely confirmatory of other travellers' narratives, but, taken as a whole, his story conjures up in the mind, we think, a more vivid picture of life among the aborigines of Australia than anything which has as yet appeared in print. At the same time it is difficult to understand why so responsible a body as the British Association should have permitted the reading of a paper of this character, without first clearing up *all* doubts as to its veracity.

Monium (from the Greek μόνος — alone), the new element announced by Sir Wm. Crookes in his presidential address, affords another instance of the application necessary in order to make headway in scientific research, the veteran chemist having persisted for eighteen years in his investigations since first suspecting a new member of the rare earths, and only within the last few weeks has this suspicion emerged into absolute certainty. Monium has a well-marked individuality, enters readily into any number of chemical alliances, and has an atomic weight not far from one hundred and eighteen. The wave-lengths of the principal lines are three thousand one hundred and twenty and three thousand one hundred and seventeen.

According to Prof. Flinders Petrie's paper in the anthropological section of the British Association, the starting point of known history must be put backwards at least a thousand years, a decision arrived at by the study of remains excavated during the last five years. Some of the objects found at Nagada were once attributed to a new race, but they can now be safely assigned to the predynastic stock, about 5000 B.C., and even earlier. It is alleged that we have now before us the development of the art of writing and the civilization of Egypt. The population of the pre-dynastic age was different in type from that of historical lines, and in the early monuments the presence of diverse types is very clear.

A high-class microscope for the amateur, the student, and the bacteriologist, at a sufficiently moderate cost to come within the reach of all, or nearly all, would-be microscopists, has long been a desideratum, and we are pleased to find that the "Fram"—a newly-designed microscope by Messrs. W. Watson & Sons—seems to us destined to meet the requirements of the most fastidious. The instrument is strong, solid, and rigid, steady at every angle, and therefore well adapted for micro-photography. In the coarse adjustment provision is made for avoiding backlash, and in the fine adjustment compensating screws are employed for eliminating slackness after prolonged use. Indeed, the entire microscope is designed to yield the advantages that have hitherto been associated only with the most expensive instruments.

* Knowledge, p. 140, June, 1898, and p. 148, July, 1898.

Notices of Books.

Audubon and His Journals. By Maria R. Audubon. With Zoological and other Notes by Elliott Coues. 2 Vols. (Nimmo.) Illustrated. Although nearly fifty years have passed since the death of Audubon, this is the first published account of his life, with the exception of that edited by Robert Buchanan, which was both inaccurate and incomplete. Audubon will be chiefly known by his great folio work on the "Birds of America," the publication of which was commenced in 1827. The author's drawings (in the original edition the text to the plates appeared separately as the "Ornithological Biography") in this magnificent work formed its chief feature, and, as has been remarked, "it is one of the few illustrated books, if not the only one, that steadily increases in price as the years go on." With the many advances that have been made of late years in the drawing of birds, as well, of course, in the process of reproducing drawings, this is very high testimony for the accuracy and beauty of Audubon's plates.

AUDUBON.

From the Portrait by Henry Inman. Now in the possession of the family.

When we look into his methods, as revealed in his own journals here published, we can better understand why Audubon's drawings have stood the test of time and criticism. His work was always first hand. Days and nights were spent in the wilds of America, alone, in the company of savages, or with a few fellow spirits watching, hunting, and procuring wild creatures, and especially birds. When he ultimately knew the habits and attitudes of a creature he would procure it, and as soon as possible, by means of wires, set it up in the flesh, and draw it, adding a few leaves or flowers which would be found growing in its habitat. It was thus that Audubon made his drawings, the like of which the world had never before seen, and it is exceedingly interesting to find in this book the history of many of these drawings written by himself. But this is not the only interest we have in reading these simple pages. They reveal the nature of the man—open-hearted, generous, forbearing, good natured, and hard working as he undoubtedly was. Although often depressed and in very poor circumstances himself, he was always ready to assist the needy and comfort the distressed. Every great character has his enemies, and Audubon was no exception, yet he never had a bitter word for them. It is surprising that he lived to such a great age, considering the amount of hard and rough work that he underwent. He would often work seventeen hours a day. Above everything, Audubon was a man of the open air. In the words of his grand-daughter (Vol. I., p. 48): "With them (the Osage Indians) he delighted to track the birds and quadrupeds as only an Indian, or one of like gifts, can; from them he learned much woodcraft; with them he strengthened his already iron constitution; and in fearlessness, endurance, patience, and marvellously keen vision, no Indian surpassed him." He was called the "American Back-woodsman," and was an ideal field naturalist.

The first of these volumes contains an account of the life of Audubon by the authoress, the European journals, the Labrador journal, and part of the Missouri River journals; while in the second we have the completion of these journals, and a number of Episodes. The "life" is an excellent and unvarnished biography. The European journals deal with Audubon's visit to Great Britain and France for the purpose of publishing his "Birds of America." This was by no means an easy task. The expense involved in the reproduction of the drawings was enormous, and the price of the book therefore very high. There were no means in those days such as we have now to get a book subscribed, and Audubon had to travel by coach all over England to obtain subscribers for his work. Besides the account of the immense labour he went through in connection with the publishing of his great work, the European journals are of intense interest for the descriptions they contain of the meetings and conversations he had with many notable men of the period.

The Labrador and Missouri journals will be chiefly valuable to naturalists, and especially, of course, to Americans, but there is so much of general interest in them that everyone who takes up the volumes will find them excellent reading. The Episodes are varied, all are interesting, and many very amusing. That entitled "The Eccentric Naturalist" is a most clever sketch, and we cannot refrain from extracting a few lines—

> "We had all retired to rest. Every person I imagined was in deep slumber save myself, when of a sudden I heard a great uproar in the naturalist's room. I got up, reached the place in a few moments, and opened the door, when, to my astonishment, I saw my guest running about the room naked, holding the handle of my favourite violin, the body of which he had battered to pieces against the walls in attempting to kill the bats which had entered by the open window, probably attracted by the insects flying around his candle. I stood amazed, but he continued jumping and running round and round until he was fairly exhausted, when he begged me to procure one of the animals for him, as he felt convinced they belonged to 'a new species.'"

The author goes on to say how he knocked down some of the bats with the bow of his "demolished Cremona," and so satisfied the naturalist. He does not, however, tell us how he must have mourned for the loss of his violin, on which instrument he was an accomplished performer.

The volumes are enriched by many valuable notes by Dr. Elliott Coues. By way of illustrations there are many portraits of Audubon and his sons, as well as three hitherto unpublished drawings of birds. The authoress has produced an estimable and lasting memorial to her grandfather Audubon, naturalist, woodsman, artist, and author.

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With Peary near the Pole. By Eivind Astrup, translated by H. J. Bull. (Pearson, Ltd.) Illustrated. Although M. Astrup died some time ago, no mention of the fact is made in this translation, nor is the author's original preface dated. These omissions are strange enough, but that a translation of this book should be published a month or two before the appearance of a full account of the expeditions by their leader is still more remarkable. Eivind Astrup accompanied Mr. Peary on his two Greenland expeditions in 1891-2 and 1893-4, and this book is a short account of these two expeditions. By far the most interesting portion of the book is that dealing with the remarkable and successful sledge journey of 1892. Although by no means a practised writer, the author describes this journey exceedingly well, the great charm of the narrative being its simplicity. It will be well to remind our readers of this journey, which was quite as remarkable in its way as the crossing of the south of Greenland by Nansen, in 1885. Peary, Astrup, Gibson and Cook, started on their journey across the inland ice from MacCormick Bay, on the north-west of Greenland, on May 14th, 1892. On May 24th they reached Humboldt Glacier, and here the party divided, Peary and Astrup continuing the journey, and the other two returning to winter quarters. On June 27th the two intrepid explorers reached the eighty-second degree of latitude, and found themselves at the edge of the inland ice, while on July 4th they arrived at the north-east coast, and so practically proved that Greenland is an island and not a continent stretching to the Pole as some have thought. It was not until August 5th that, after innumerable hardships and incessant toil, Peary and Astrup gained winter quarters and comparative civilization. Besides the descriptions of the expeditions and their equipments, the book contains some valuable information on the customs, dress, and language of the Esquimaux, and the manner in which they live. This information is especially interesting, since it refers to tribes about which very little is known. The information, however, is scattered through the book, and not being systematically arranged loses much of its value. The translator has done his work well, and the book well deserves reading.

Cantor Lectures on Gutta-Percha. By Dr. Eugene Obach. (Wm. Trounce.) Illustrated. Gutta-percha is not, some may think, a very entertaining subject for a course of lectures, but a different opinion may be formed by a perusal of the Society of Arts' course of three lectures delivered by Dr. Obach nearly a year ago. The plant was subordinated to useful purposes by Sir Wm. Hooker and Dr. Siemens in the year 1847, and the Society of Arts deemed it fitting to celebrate the jubilee of its introduction into commerce by a course of lectures, which are embodied here, and suitably illustrated with photographs and diagrams of the processes employed in preparing the raw material for the market and its subsequent manufacture into various useful articles. The history, geographical distribution, botanical structure, and cultivation of the gutta-percha tree form the subject of the first lecture, while the second and third deal with the processes for cleaning, hardening, and so on. Among the many uses to which gutta-percha has been put, that for making ice-boats, as in the case of Lady Franklin when in search of her husband in 1850, seems to us most curious. A useful series of tables is appended at the end of the volume, giving analyses, imports and exports, and so on; indeed, we know of no work where so much and varied information, in an equivalent space, may be found on gutta-percha as in Dr. Obach's lectures here reproduced in convenient form for reference.

The Wonderful Century: Its Successes and its Failures. By Alfred Russel Wallace. (London: Swan, Sonnenschein & Co.) 7s. 6d. That this book is from Dr. Wallace's pen is guarantee sufficient that it is interesting and well worth reading. In the hands of such an author we expect that the subject will be dealt with in a fascinating and invigorating style, and we are not disappointed. As Dr. Wallace himself says, he has produced an appreciation of the century rather than its history. But the book is by no means full of jubilant expressions relating to the many wonderful successes of the last hundred years; more than half the volume is concerned with what the author regards as its failures. Among these the questions of vaccination, phrenology and spiritualism are discussed, the first named occupying a very considerable portion of the entire volume. The author has strong views on these subjects, and does not hesitate to express his opinions in vigorous language. This makes it advisable to offer a word or two of caution to readers who propose to study the book under notice. It by no means follows that because an author has attained pre-eminence in any one department of scientific knowledge, as Dr. Wallace has done in the realm of natural history, he is thereby qualified to give a final opinion on every controversial question which may arise out of the advances that science has made. There are many who are not prepared to accept Dr. Wallace as a judge upon such matters as the value of vaccination, or the claims of phrenology to be regarded as a science; and while admiring his manly English and his clear expression of what he thinks, we must point out that his conclusions are considered erroneous by numbers of equally eminent men of science. Doubtless many of Dr. Wallace's sentences will find their way into phrenologists' advertisements and the pamphlets of anti-vaccinators, but that does not constitute them deliberate expressions of the present state of scientific opinion. Dr. Wallace himself must recognize that he has no more right to decide these questions than an eminent chemist would have to pass judgment in matters of pure biology. If this is borne in mind the reader will derive both pleasure and profit from the perusal of Dr. Wallace's work.

Essays on Museums and other Subjects connected with Natural History. By Sir William Henry Flower, K.C.B., etc. (Macmillan.) Illustrated. 12s. net. We have to thank Sir William Flower for republishing these essays in book form. The earliest of them was written in 1870, and notwithstanding the great advance in scientific knowledge since that date, all these essays, with the exception of a few minor details, have stood the test of time, and are as interesting and instructive to-day as they were when first penned. The book opens with seven chapters on museums, a subject with which the author is, of course, eminently fitted to deal. If anyone requires advice as to how to build, plan, and fill a museum to the best advantage, or should anyone be at all hazy as to the true value of a museum, let him read these chapters. The last forms a brief history of Hunter's wonderful collection, now the museum of the Royal College of Surgeons. The next section of the book, devoted to biology, contains eight essays on various subjects. The chapter on whales, past and present, and their probable origin, is especially interesting. The chapters in the section dealing with anthropology, that much neglected science, should be read by everyone. The concluding chapters are biographical sketches of Prof. Rolleston, Sir Richard Owen, and Prof. Huxley, and an eulogium on Charles Darwin. The book is a mine of information of a very varied character conveyed in simple but eloquent language, and our only criticism is that an index would have rendered it more useful.

XUM

Elements of Descriptive Astronomy. A text-book by Herbert A. Howe, A.M., SC.D. (London: George Philip & Son.) This is a delightful text-book, intended not only for students at college, but for those also who attend the more comprehensive school of Nature herself. Dr. Howe touches upon each of the widely varying subjects which make what is to-day called the "new astronomy," and he discusses reasonably and without prejudice the hard questions that come up for answer on every side. Indeed, when he comes to the nebular hypothesis he deprecates, by a well-turned parable, the necessity of formulating any answer, of making any prophecy as to what will be the ending of the earth and sun.

But the "text-book" of the student should be his reference book when he has become a working astronomer. We once heard of a computer who could repeat Bottomley's logarithmic tables, in whole or in part, from memory, but unfortunately this power was exceptional, or rather unique, among the astronomers of his day. We ourselves cannot trust our memory to recall accurately the simplest trigonometrical rule or formula, and it is a question of time to work all problems out from first principles. Therefore, since the author says in his preface that he will welcome any suggestions for a second edition, we believe that it would still further add to the usefulness of this already valuable work if he furnished appendices not only of the "names of stars," the "astronomical constants," and of the "planetary data," but also of the formulæ most commonly used, say for the conversion of the altitude and azimuth of a star into its longitude and latitude, or right ascension and declination.

SHORT NOTICES.

Industrial Electricity. Edited by A. G. Elliott, B.SC. (Whittaker & Co.) Illustrated. 2s. 6d. This volume is one of a series of books on electro-mechanics. Apparently recognizing the fact that we have yet to learn a great deal from the French on matters scientific, Mr. Elliott has planned his book from a treatise by Henry de Graffigny. The principal applications of electricity in everyday life are popularly explained, that is to say, the non-mathematical reader may peruse it with profit, but the small size of the work does not admit of much detail. However, the other volumes of the series—some of which, by the way, have already appeared, whilst others are in preparation—are intended to enter more minutely into the various branches of applied electricity.

Notes on Observations. By Sydney Lupton, M.A. (Macmillan.) 3s. 6d. An attempt is here put forth to make clear to the scientific student the reasons for adopting the present system of mathematical nomenclature. The introductory chapters are devoted to philosophic reasoning, and the rest of the book is given up to rather abstruse problems, which will appeal more to the higher mathematical student rather than to physicists and chemists, for whom the book is really intended. References are given at the end of each chapter for those students who wish for fuller information. We think that there is room for more books of this kind—books which in a sense control a student's thinking powers somewhat after the manner in which the governor-balls of a steam-engine regulate the action of that useful mechanism.

Elementary General Science. By A. T. Simmons, B.SC., and L. M. Jones, B.SC. (Macmillan.) Illustrated. 3s. 6d. As an introduction to natural philosophy this book will be found very useful. Its chief merits rest upon the fact that all the fundamental principles of the sciences are presented with exceptional clearness, and the whole of the information is so thoroughly up to date as to form a solid basis for more advanced work.

Practical Radiography. By A. W. Isenthal and H. Snowden Ward. Second Edition. (Dawbarn & Ward.) Illustrated. 2s. 6d. Although only in its second edition, this work has been so thoroughly revised that it may be almost regarded as new. All the recent innovations in the infant science have been interpolated in their proper places and minutely explained, more particularly as regards the practical aspects of the subject. Some very good photographs illuminate the text here and there. As a handy guide to practical work of this kind there is, as far as we know, no better book available.

Elementary Chemistry. First Year. By T. A. Cheetham. (Blackie.) Illustrated. 1s. 6d. By way of supplementing elementary lectures on chemistry with practical work in the laboratory, Mr. Cheetham's book is admirable. The so-called "test-tubing" is replaced by simple experiments which have for their object the development of the student's reasoning powers, ample scope for which is to be found in the resolution of chemical compounds into their elements, or *vice versâ*, and so on.

Scientific Method in Biology. By Dr. Elizabeth Blackwell. (Elliot Stock.) The main theme of this book is the necessity for practising more humane methods of medical research. It is maintained that truth, not curiosity, is the real aim of all scientific investigation, and therefore medical research should be pursued on strictly humanitarian lines. Many students can extract rare sport out of the sufferings of dumb creatures, and this morbid passion may retain its hold on the professional man in after years, when as a surgeon he is called upon to minister to afflicted humanity. All those who desire to maintain medical science at its highest level from a purely moral aspect will find much here to sustain and encourage them in their efforts to minimise human woe.

First Stage Magnetism and Electricity. By Dr. R. H. Jude, M.A. (Clive.) Illustrated. 2s. Dr. Jude follows the syllabus of the Science and Art Department, but it is not by any means a cram-book—a result which too frequently obtains in books written for examination purposes. The only other important points to notice are the useful summaries at the end of each chapter, and the careful attention bestowed on the all-important subject of potential—a slough in which most students flounder hopelessly.

The Barometrical Determination of Heights. By F. J. B. Cordeiro. (Spon.) 4s. 6d. An essay originally entered for the Hodgkin Prize Competition at the Smithsonian Institute, and mentioned as being *good*. Various formulæ are tabulated which, according to the author's idea, are more accurate than the old tables, these being faulty in the formulæ rather than in the method. But why a pamphlet of about thirty pages should cost four shillings and sixpence is beyond our comprehension!

The Adventures of Robinson Crusoe. (London: *Review of Reviews* Office.) 6d. This is still another edition of the famous novel, retold from Defoe's original, and edited by W. T. Stead. It is printed in large clear type, and illustrated throughout with a number of new drawings. Some of these new renderings of old friends are quite unintentionally humorous, notably that on page 89, representing the reunion of Friday with his old father. Mr. Stead has done well to reproduce a story which must always appeal to Englishmen all the world over as reminiscent of the days when all the world was young, and we first made the acquaintance of Robinson Crusoe.

We have received from the *Review of Reviews* office a selection of the Penny Poets series, and we gladly direct the attention of teachers in elementary schools to these most admirable books.

BOOKS RECEIVED.

Zoological Results based on Material from New Britain, New Guinea, &c., 1895, 1896, and 1897.—Part I. By Arthur Willey, D.SC. (Cambridge University Press.) Illustrated. 12s. 6d.

Catalogue of Scientific Periodicals. Vol. XL. (Smithsonian Miscellaneous Collections.)

The Rutherford Photographic Measures of Stars. By Herman S. Davis, PH.D. (Reprinted from the Annals of the New York Academy of Sciences.)

Birds of the British Empire. By Dr. W. T. Greene. (Imperial Press.) Illustrated. 5s. net.

The Fern World. By Francis George Heath. (Imperial Press.) Illustrated. 5s. net.

Applied Geology.—Part I. By J. V. Elsden, B.SC. (Quarry Publishing Co., Ltd.) Illustrated. 5s.

Geology for Beginners. By W. W. Watts. (Macmillan.) Illustrated. 2s. 6d.

Tylar's Catalogue of Photographic Appliances. (High Street, Aston, Birmingham.) Illustrated. 6d.

Stories of Starland. By Mary Proctor. (G. W. Bacon & Co., Ltd.) Illustrated.

The Unconscious Mind. By Dr. Alfred T. Schofield. (Hodder & Stoughton.) 7s. 6d.

Outlines of the Earth's History. By Nathaniel Southgate Shaler. (Heinemann.) Illustrated. 7s. 6d.

Meteorological Observations for the Year 1897. (Rousdon Observatory, Devon.) By Cuthbert E. Peek, M.A.

Wireless Telegraphy. By Richard Kerr, F.G.S.; with Preface by W. H. Preece, C.B., F.R.S. (London: Seeley & Co., Ltd.) 1s.

XUM

Conducted by Harry F. Witherby, f.z.s., m.b.o.u.

Change of Nesting Sites of Common Tern and Ringed Plover.—Both the Common Tern and Ringed Plover breed commonly in the sands and bents to the north of Peterhead. The former bird is ever shifting its breeding grounds, perhaps through annoyance from fisher boys, who are persistent harriers of their nests. In former years I have always come across small breeding colonies within five miles of the town, either immediately above high water mark or on the bents. This year I found none, but inland I came across two colonies, one in the middle of a field of rye grass, and the other in the middle of a turnip field, where they certainly had more chance of raising their young. Is this reasoning on their part, or what? The same change of breeding grounds I observed on the part of the Ringed Plover. There were certain furrowed spots on the sand or back a little on the bents where you could always find their eggs, and where their piping was incessant, but this year there were hardly a pair in these parts. Nor had they mingled with the Terns in the fields, but they were piping commonly all along where the bent adjoins the cultivated land. Had two or three pairs been there it had not been noticeable, but they seemed all to be there. I wonder if they were going near the town so as to get their protection when Crows were hovering about?—William Scole, Peterhead.

Migrating Wagtails at Peterhead.—In years past, during September, I used to notice Pied Wagtails numerously, some nights in hundreds, near Fettes College in Edinburgh. They are every year very noticeable birds all over this region during the latter three weeks of August. In the spring they are very numerous as they push northwards, but nothing to what they are in August. They are just now in family parties, though later you would think that three or four families combine. They are in no hurry to travel southwards, perhaps because they have abundance of flies here during the herring season. There is always a fair sprinkling of the Grey Wagtail, but they are a little later in migrating.—William Scole, Peterhead.

Squirrels and Birds.—Squirrels are becoming very common in the woods and plantations of Ireland, and certainly form a charming addition to our somewhat slender list of wild fauna. The price which we must pay for the pleasure of watching them is, however, scarcely understood. Not only do they rob our gardens and orchards, but they are proving formidable adversaries to the increase of bird life. Nests are robbed without scruple, eggs and young devoured; and a squirrel was lately seen leaping triumphantly on the garden wall with a full-fledged Robin in his mouth. A neighbour of ours has proclaimed a war of extermination against the marauders, which, not content with stealing the food prepared for his young Pheasants, proceeded to eat the precious chicks themselves. It seems that we cannot allow Squirrels to increase at their own sweet will without making sacrifice for their sakes of the birds which are equally valued.—C. Maud Battersby, Cromlyn, Rathowen, Ireland.

Moorhen Chasing Stoat.—On August 16th I was in a canoe on the River Derwent, floating down stream and hardly making a sound, when I saw on the bank a Moorhen hunting a stoat. The stoat was galloping along, and the Moorhen kept making short swift runs at it, but each time striking distance was reached the bird stopped short. I kept the canoe still and watched till pursued and pursuer disappeared among some bushes. The Moorhen may have had young ones—a second brood—and the stoat have tried to rob her nest. The Moorhen uttered an alarm note incessantly, and the stoat seemed to me to utter every now and then a low short squeal, whether in anger or terror I cannot say.—Basil W. Martin, Darley Abbey, Derby.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

SUNSPOTS AND LIFE.

By Alex. B. MacDowall, m.a.

Is there any connection between the sunspot cycle and physical phenomena around us? We may reply with a confident affirmative, for the proof that magnetic variations are related to that cycle is clear and cogent. The same may be said about frequency of auroras.

There can be little doubt that the electrical condition of our globe with its atmosphere touches life at many points. (A familiar example is the susceptibility of some people to the influence of an approaching thunderstorm.) The subject, however, is largely a *terra incognita* at present.

Does the sun give out more heat when spotted, or when (comparatively) spotless? And does our atmosphere manifest such difference, if it exists? Have we more severe winters, hotter summers, etc., during one phase of the sunspot cycle than during the opposite phase? and, if so, what is the nature of the relation? Such questions are still (in the opinion of many) *sub judice*.

There is reason to believe, I think, that we have more winter cold about the time when there are few spots than when there are many. Some months ago I gave, in these pages,* two curves in illustration of this view; one, of frost days at Greenwich in the first quarter of the year, the other, of days of northerly wind in the winter half of the year. It would seem that the sun is hottest when spotted. The cold of winter is mitigated. Some say that the spotted sun gives us hot summers as well as mild winters.

Now we know how a great deal of cold in the late winter and early spring affects the life of plants, retarding their growth, and the life of migratory animals, delaying their return. If, then, this cold varies periodically in a cycle of about eleven years, should there not be a corresponding variation in the data of phenology?

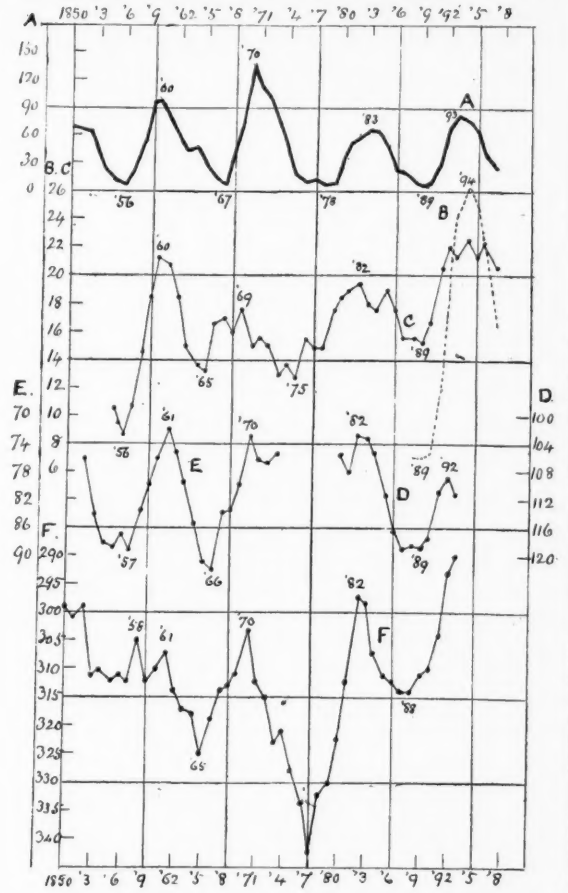
This branch of science, *phenology*, has not yet come within the ken of "the man in the street." I hardly need say here, however, that the practical phenologist notes, year by year, the dates at which given plants come into leaf or flower (or other phase), the dates at which certain animals are first seen.

Do we, then, find that the variations in those dates show any correspondence with the variations of temperature and of the sun-spots in a period of eleven years? To this

* Knowledge, October, 1897. "Coming Cold."

an affirmative reply has been given recently by the eminent French astronomer, M. Camille Flammarion.*

Some time ago he commenced observing the chestnuts at Juvisy Observatory, near Paris, recording the days on which leaves and flowers were first seen. He has now a uniform series of thirteen years of such records (1886—1898). He draws a curve to represent (say) the date of first flowering of the chestnut, in this way: The dates, ranging from 4th April to 9th May, are first changed into numbers, calling the latest No. 1, the second latest No. 2, etc. Then the thirteen years series of these numbers is smoothed with averages of four (averaging the first four, then the second to the fifth, and so on). These smoothed values yield the curve B in our diagram.† The thing to be noted is, that high points in it represent early dates, and low points late ones; and there is good agreement with the last sunspot wave (curve A), the earliest dates being near sunspot maxima and the latest near minima.



A.—Sunspot Curve. B.—Smoothed Curve of first flowering of chestnuts, near Paris. C.—Smoothed Curve of return of Swallow to Central France. D.—Smoothed Curve of average first flowering of five plants in Hants. E.—Smoothed Curve of first flowering of *Ribes Sanguineum*, Edinburgh. F.—Smoothed Curve of death-rate of male persons, eighty-five and upwards, in England. (D, E, and F are inverted curves.)

These data are obviously too meagre, however, to base much upon, and M. Flammarion has recourse to several longer records, showing the dates of return of some migratory birds (the swallow, the cuckoo, the nightingale) at a place near Moulins, in the centre of France (the Parc de Baleine). The longest record is that of the swallow, and the smoothed curve for it (drawn on the same principle) is that marked C. A correspondence of the same kind, not, indeed, absolutely perfect, is here apparent. The swallow returns later, on the whole, near minimum sunspots than near maximum. The dates here range from 19th March to 11th April. Curves of the two other birds are given by the author as pointing to the same influence.

With regard to temperature, M. Flammarion finds that a smoothed curve of the mean temperature of March and April (months of great importance to vegetation) corresponds with the sunspot curve, and also fairly represents the temperature variation of the whole year.

Coming to our own country, we may, if I mistake not, find the same influence at work; and I may be permitted to recall, in this connection, some curves which have appeared elsewhere.

D is a curve drawn from data in the Annual Reports on phenological phenomena presented to the Royal Meteorological Society. It represents the flowering of plants in a district of Hants. The five annual dates of first flowering of five plants (viz., coltsfoot, wood-anemone, blackthorn, white oxeye, and dogrose) from 1878 to 1895, translated each into the number of the day in the year, are added together and an average taken. Then the series is smoothed with averages of five (to get rid of minor waves of variation). Here a high number represents the opposite of what it does in M. Flammarion's curves, viz., a late date, while a low number represents an earlier date. The curve is an inverted one, the numbers increasing downwards. E is a curve got similarly from a record of the first flowering of *Ribes Sanguineum* (or flowering currant), at Edinburgh, 1850-75.

Both of these curves appear to indicate late flowering about the time of sunspot minima, and early about the time of maxima.

Cold retards the beginnings, the first signs of life; it often accelerates the end of life. We know that a sharp snap is fatal to many of the aged and the weak. The Registrar-General's reports give us an opportunity of seeing how the death rate of old people varies from year to year. If we take the series for males eighty-five and upwards, and make a smooth (inverted) curve of it (F),* we find it has considerable suggestions of a relation to that variation in winter cold whose effects we have been tracing, and the origin of which, as of much else, may probably be found where—

> "The very source and fount of day
> Is dashed with wandering isles of night."

ECONOMIC BOTANY.

By John R. Jackson, A.L.S., etc., *Keeper of the Museums, Royal Gardens, Kew.*

ZYGOPHYLLEÆ.—A family usually known as the Guaiacum order, consisting of trees, shrubs, and herbs, found abundantly and widely dispersed in the tropical and warmer parts of the globe, the spiny species being characteristic of the desert vegetation of Egypt and Western Asia. Many of the

* See *Bulletin de la Société Astronomique*, for June, 1898.

† I should perhaps state that these two curves, B and C, are not an exact copy of M. Flammarion's diagrams, but are drawn from his figures. The four year average is in each case put down to the *third* year of the group (with slight want of symmetry). These two curves should be considered independently; they are drawn with the same vertical scale for convenience.

* See *Lancet*, January 1st, 1898.

species are characterised by the presence of resin, and the woody species by their extreme hardness. The most important economic species of the order are *Guaiacum officinale* and *G. sanctum*, both of which furnish the well-known hard wood, Lignum vitæ, of commerce. The first is a tree of twenty or thirty feet high, crowded with numerous, spreading, jointed branches, covered with long green leaves and numerous bright pale blue flowers, which give the tree a very handsome appearance. It grows in most of the West Indian Islands, more particularly in Hayti, Jamaica, and Cuba, and is found also in Columbia and Venezuela. The second species, *G. sanctum*, grows in Cuba and the Bahamas, but is not found in South America, though it occurs at Key West, in Florida. Guaiacum wood or Lignum vitæ is imported in large logs or billets, weighing sometimes as much as a hundredweight. The bark is removed before exportation. The wood is often as much as a foot in diameter, and shows on a cross section a marked distinction between heartwood and sapwood, the former being of a dark greenish colour, owing to the presence of resin, which is known commercially as gum guaiacum, and the sapwood being of a light yellow, containing no resin. The heartwood is one of the darkest and hardest woods known, and is valued for these qualities as well as for its great durability, for which reason it is used largely for making ships' blocks, pulleys, skittle balls and bowling balls, rules, pestles, etc., and medicinally as a stimulant, diaphoretic, and alterative. It was formerly much used in syphilitic and cutaneous affections, chronic rheumatism, gout, scrofula, and similar diseases. For these purposes it was seen in chemists' shops in the forms of chips, shavings or coarse powder. It is, however, seldom used medicinally at the present time. The best kind of Lignum vitæ comes from San Domingo; other qualities are imported from Hayti, Bahamas, and Jamaica.

Guaiacum resin occurs either in lumps or small round pieces known as tears. Externally it is of a brownish-green colour, breaking with a clean, glassy green fracture. It has no smell, except when warmed or rubbed, when it emits an aromatic odour. It possesses the same properties as the wood, and is used in medicine for similar purposes.

A curious plant belonging to this order is that known as the creosote plant (*Larrea mexicana*), a shrubby plant of North America. A resinous substance or lac covers the twigs, which is scraped off by the Indians and melted into balls. It is considered by them as efficacious in the case of rheumatism.

Geraniaceæ.—A group of herbs or shrubs distributed over the globe, the Pelargoniums being found abundantly at the Cape of Good Hope. The characteristic properties of the plants are astringent, aromatic and fragrant. They are, however, more valued, horticulturally, for the beauty of their flowers than for their economic properties. From this point of view the most important is, perhaps, the rose leaf geranium (*Pelargonium capitatum*), which is largely cultivated in the South of France, Turkey, Algeria, and Spain, for the fragrant oil which is distilled from its leaves, and is used as a perfume, both by itself and for adulterating attar of rose. *Sarcocaulon Heritieri*, a fleshy plant of the Cape, is peculiar in having a cylindrical stem which, in its older stages of growth, becomes so highly charged with a hard wax that all traces of vegetable tissue are lost, and the stem breaks with a short brittle fracture. It burns freely, and is sometimes used as a torch or candle.

The acid character of the plants of this order is well developed in the Blimbing of India (*Averrhoa Bilimbi*), belonging to the tribe Oxalideæ. It is a small tree, much cultivated in India for the sake of the fruit, which is cylindrical in shape, about three inches long and one inch in diameter, somewhat resembling a gherkin. It is extremely acid in its fresh state, but is often preserved in syrup, or candied, or used as a pickle. The carambola is a closely allied fruit, native also of the East; it differs, however, in shape from the Blimbing as it is distinctly marked with prominent ribs or wings running parallel down the sides of the fruit. It is the produce of *Averrhoa Carambola*. From the wood sorrel (*Oxalis acetosella*) oxalic acid is prepared, while the tubers of several other species of *Oxalis* are edible; such, for instance, as *O. crenata*, a native of Peru, but much cultivated about Lima. The tubers are about the size and shape of large walnuts, but are not unlike small potatoes in general appearance. Their naturally acid flavour is dissipated by cooking when they are eaten by the people, and are occasionally seen in the markets of this country. At the time of the early potato murrains it was thought that the tubers of this oxalis might under cultivation become a regular substitute for the better known tuber, but this has never been realized. Other species, the tubers of which are eaten in Bolivia and Mexico, are *O. tuberosa* and *O. Deppei* respectively, both of which were recommended for cultivation with us along with *O. crenata*.

Rutaceæ.—This large and very important order consists chiefly of trees and shrubs, widely scattered over the warmer temperate regions of the globe, being especially numerous in Australia, South Africa, and tropical America. The order is characterized by the presence of bitter, aromatic, or fragrant oils, found abundantly in glands covering the leaves or fruits, as in the rue and the orange tribe, and in wart-like protuberances in the species of *Zanthoxylum*. The order is of much value from an economic point of view in consequence of its including the several species of *Citrus*, furnishing the oranges, lemons, and citrons of commerce. These fruits are far and away the most important products of the order, notwithstanding there are many others of very varied interest and value.

The sweet orange, which is also known as the Chinese or Portugal orange, is the fruit of *Citrus Aurantium*, a small, much branched tree of about twenty feet in height, which is scarcely known at the present time in a wild state, but which seems to have been originally a native of Northern India or Southern China, and not introduced into Europe till the middle of the fifteenth century. At the present time the sweet orange is cultivated very extensively in many parts of the Mediterranean district, as well as in Spain, Portugal, Madeira, the Azores, and many other countries possessing a suitable climate. In the South of Europe the trees flower in April and May, and the fruits ripen about a year after. A very large number of varieties of the orange have been described, the most important being those affecting the size, form or quality of the fruit. The more important varieties are those known as the China orange, the St. Michaels, the Blood or Malta, in which the pulp and juice are of a blood-red colour, the Mandarin and Tangerine. Orange trees are remarkably prolific fruit bearers, and it has been stated on good authority that one tree has been known to yield twenty thousand fruits fit for exportation. Enormous quantities of fruits, which are ever increasing in bulk, find their way into the English market, and when it is borne in mind that each fruit has to be gathered separately, wrapped in paper and packed, together with the cost of the boxes, freight and labour throughout, and after all this the fruits can often be sold in the retail market at twenty for a shilling, it seems very remarkable that the crops are made

to pay even for the ground upon which they are grown. The orange is one of the most wholesome fruits known, and a truly valuable refrigerant, and it is remarkable that very few people dislike the orange. Besides the use of the pulp as an edible, the rind of the fruit, known as sweet orange peel, is valued for its aromatic, stimulant, and slightly tonic properties. The essential oil contained in such large quantities in the glands of the rind is extracted in the South of France and at Messina both by the sponge and ecuelle processes, which will be more fully described when considering the lemon. Large quantities of oil of orange peel are used in Germany in the preparation of perfumes and liqueurs.

From the flowers a volatile oil is distilled, known as oil of neroli, which is one of the ingredients in Eau de Cologne, and is also used in perfumery and liqueurs. Besides this, the leaves and young shoots of the orange plant yield by distillation another kind of oil known as *Essence de petit grain*. The bitter or Seville orange, which is a variety of the last named, is rather a smaller tree, and does not seem to be cultivated in India except in gardens, but it is extensively grown in the same countries as the sweet orange. The chief distinction is that the rind of the fruit has a bitter aromatic taste. It is used in making candied orange peel. The flowers are also used in distilling for oil of neroli. This variety, which is now classified as *Citrus Aurantium*, var. *Bigaradia*, was at one time considered a distinct species under the name of *C. vulgaris*. The Bergamotte orange is another variety (*C. Aurantium*, var. *Bergamia*). Its chief distinctions from the sweet orange are its smaller flowers, which are known by their delicate and peculiar odour, and the paler colour of the fruit. The Bergamotte orange is grown chiefly near Reggio, in Southern Calabria, and more sparingly in Sicily, Southern France, and elsewhere. The volatile oil obtained from the rind of the fruit forms the Essence of Bergamot of the chemist, the principal use of which is in perfumery, while from the pulp is obtained, by expression, the acid juice which forms a portion of the commercial lime-juice.

Citrus medica is the tree that produces the citron fruits. The plant does not exceed ten or twelve feet in height, and, like the species before mentioned, is not known in a truly wild state. It is, however, to Northern India that it is supposed to belong, and to have spread westward at a very early period, being cultivated in Syria in the time of Josephus, and probably introduced into Italy in the third century, from whence it spread through the Mediterranean regions. Its cultivation at the present time is chiefly carried on in the neighbourhood of Florence, in Sicily, Corsica, and the Riviera, and to a smaller extent in the Azores, Madeira, India, and China. Citron fruits are mostly of very large size, sometimes weighing several pounds, and measuring eight or nine inches in length, and four or five in diameter. It has a thick rind and a very small proportion of pulp. The rind is much used for making candied citron peel for dessert or confectionery purposes. Like all the orange tribe the rind is filled with oil glands, which is extracted in the same way as is lemon oil or essence, next to be described. Citron essence or oil, usually known as essence of cedrat, is much valued in perfumery on account of its agreeable odour. *C. medica*, var. *Limonum*, is the lemon, which is a straggling bush or small tree, ten to twelve feet high. Under cultivation it is now found throughout the Mediterranean region, and in all tropical and sub-tropical countries. It seems to have made its first appearance in Europe about the latter part of the fifteenth century. Lemons come to this country from Southern Europe, principally from Sicily, but also from Spain, packed in boxes or chests, and, like oranges, wrapped separately in paper. Lemon peel is candied in the same way as citron when it is used in confectionery and for culinary purposes. The dried peel is used in medicine. In its fresh state lemon peel is studded with numerous receptacles filled with a very fragrant volatile oil, which, when expressed and purified, is known as oil or essence of lemon. For expression two processes are employed, one known as the ecuelle and the other as the sponge process. For the purpose of expressing, or distillation—for some oil of an inferior quality is obtained in this manner—only the small or irregular fruits are used, the best shaped being selected for exportation. The fruits are gathered before they are quite ripe, as the oil is of a better quality than when they are fully matured. The peel is first cut off by the workman in three longitudinal pieces, and the portion containing the pulp is placed on one side. On the following day the pieces of peel are operated upon in the following manner: the workman takes the ecnelle, which consists of a shallow basin-like funnel, the spout portion of which is closed at the bottom, the inside of the basin is studded with sharp points against which the rind is pressed by the workman, this ruptures the oil vessels, and the oil trickles into the closed spout, which, when full, is emptied into another vessel. The sponge process is practically the same, except that in place of an ecuelle a sponge is used, which becomes saturated with the oil and when full is squeezed out. Prepared by either process, oil of lemon is of a light yellow colour, and has a very fragrant odour. It is mostly exported in small cylindrical coppers. Lemon juice is the concentrated acid juice of the pulp, which, together with that of the bergamot and lime, are the bases from which citric acid is made.

The acid lime, from which the bulk of the lime juice is now obtained in the West Indies, is the fruit of *Citrus medica*, var. *acida*, while the sweet lime is from *C. medica*, var. *Limetta*.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Perrine's Comet (1898. I.).—Elliptical elements have been computed for this object by Herr K. Pokrowskij from observations between March 21 and May 21, and he finds the period three hundred and twenty-two and a-half years. This comet is possibly still perceptible in powerful telescopes, and is moving very slowly westwards, in the western part of the Lynx, its place on October 11th being R.A. 6h. 24m. 59s., Dec. + 50° 24·8′, and on October 19th, R.A. 6h. 16m. 53s., Dec. + 50° 17·4′.

Wolf's Comet continues visible, though it is a decidedly faint object. It is situated in Monoceros, and at the beginning of October will be at a distance of about one hundred and forty-five millions of miles from the earth. Its position on October 1st will be R.A. 6h. 39m. 28s., Dec. + 3° 33·2′.

Encke's Comet, and the comets of Perrine and Coddington discovered in June are too far south for observations in this country. Giacobini's comet is probably too faint to be seen in ordinary instruments.

The Perseids of 1898 certainly formed a stronger shower than usual, and appear to have been very generally observed. M. C. Flammarion reports that on August 10th from 10h. to 14h. 30m. they were watched from the observatory at Juvisy, and that five hundred meteors were registered and marked down on a map of the heavens. At the Paris observatory Mlle. Klumpe observed two

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hundred, and it was estimated that altogether six hundred shooting stars were seen here. In England the sky was not so clear on August 10th as on August 11th, but many meteors were seen on both nights. The very exceptional clearness of the atmosphere on the latter date enabled the best view to be obtained, and the progress of the shower was watched by Prof. Herschel at Slough, Mr. Corder, Bridgwater, Mr. Blakeley, Dewsbury, Rev. S. J. Johnson, Bridport, Rev. T. E. R. Phillips, Yeovil, Mr. Besley, Exeter, Mr. Townshend, Paignton, Mr. King, Leicester, the writer at Bristol, and many others.

The display was sufficiently marked to attract the notice of many people, who, though quite unaware that such an event was expected, had their attention accidentally called to it by the surprising frequency and occasional brilliancy of the meteors. Though the maximum of the shower must have probably occurred before the night of August 11th, a single observer watching the sky interruptedly might have counted about fifty meteors per hour, and of these about forty would have been Perseids. They were characterized by the usual swiftness of motion, and almost invariably left green streaks. In several cases the streak would brighten up in a very perceptible manner after the nucleus had vanished; some of the meteors were, in fact, only observed in the form of streaks, the nuclei having been so faint as to elude observation. The whole duration of the shower appears to have been from July 14th to August 17th, but it was very feebly manifested at the opening and closing stages. The centre from whence the meteors diverged was variously fixed by several observers as under :—

Date.		Radiant.		Meteors.		Observer.
July	20	21°	+51°	4	...	W. E. Besley.
,,	28	32	+55	5	...	,,
,,	29	31	+54	6	...	E. R. Blakeley.
August	10	45	+58	4	...	A. King.
,,	11	45	+58	25	...	E. R. Blakeley.
,,	11	45	+58	40	...	W. E. Besley.
,,	11	46·4	+57·6	81	...	W. F. D.
,,	11	46	+58	28	...	A. King.
,,	11	39 45 46	+60 +57¼ +53	—	...	T. E. R. Phillips.
,,	11	46	+56	20	...	H. J. Townshend.
,,	14	54	+59	4	...	A. King.

Fireballs.—In twilight, on August 11th, and before observers had commenced watching for the Perseids, a beautiful meteor, rivalling Venus at her best, and slowly pursuing a long horizontal path in the southern sky, was seen by many persons. Amongst these were, fortunately, several astronomical amateurs who recorded the apparent path very accurately. Descriptions were received from Bridgwater, Slough, Bristol, London, Henley-on-Thames, Stroud, Gloucester, Wimbledon, Clevedon, South Croydon, Bengeo, Herts, Birmingham, Eastbourne, the English Channel, and other places. The nucleus of the meteor was white, and as it slowly travelled from east to west it threw off a shower of yellowish sparks, and finally broke up into fragments. A mere remnant of the meteor pursued its course with an exceedingly slow motion about eight degrees further; it looked like a spark sailing along on the wind and vanished suddenly without any train. On examining the observations the meteor was found to be an Aquarid, with a radiant at 339° – 10°. When first seen its height was sixty-six miles over the mouth of the Seine, France, and at disappearance its height was forty-one miles over a point three miles south-west of Okehampton, Devon. The length of its observed flight was one hundred and ninety-six miles, and computed velocity twenty-two miles per second.

On August 21st, at 9h. 16m., during a thunderstorm and frequently vivid lightning in the West of England (when, however, a part of the sky remained clear), a very fine meteor was noticed at several places. An excellent view of it was obtained by Prof. Herschel at Slough, who says that at first the nucleus was yellowish and as bright as Jupiter, then it expanded pretty rapidly until it equalled Venus, and became of a splendid, light emerald green colour, finally increasing to $1\frac{1}{2}\times$ Venus after going a little further. The course may have begun one and a half degrees below η Aquarii, but it must have been thirty degrees long from 330° – $6\frac{1}{2}$° to 303° – 20°. Duration of flight five seconds. When as bright as Venus the nucleus appeared to be globular, but afterwards assumed a crescent shape with a tail of yellow sparks about two or three degrees long, and some six or eight minutes wide. The same meteor was observed by Mr. A. R. Schutz at Worthing, sailing slowly from 345° + 10° to 318$\frac{3}{4}$° + 5°, when it disappeared suddenly. He describes the colour as pale bluish-green—the tail was red. At Cirencester the meteor was observed by Miss E. Brown, who estimated the nucleus as more brilliant than Venus. The direction was from the square of Pegasus, north to south, below γ Aquarii. The colour was white changing to greenish-blue. The meteor was directed from a radiant point at 5°+13°, close to γ Pegasi. It began over France, about fifteen miles south-east of Cressy, at a height of sixty miles, and its flight being directed westwards, it crossed over a portion of the English Channel, and disappeared over a point about thirty-six miles south of Brighton. Whole length of path ninety-five miles, and velocity about nineteen miles per second. The meteor belonged to a tolerably well-known minor shower, and it seems highly probable that the splendid fireballs observed in Austria on August 25th, 1884, and in Germany on August 26th, 1858, were members of the same stream, as their radiants, determined by Von Niessl, were in the same region.

During recent observations of the Perseids, a number of the same meteors were observed at two or more stations. The real paths of these have been computed, and the average heights, etc., of fifteen of these were as follow :—

Height at First Appearance.	Height at Disappearance.	Length of Path.
74½ miles.	54 miles.	47½ miles.

The late somewhat brilliant return of the Perseids and the success which attended the observations encourage the hope that the year 1898 will prove a memorable one as regards the exhibition of meteoric showers. In November next, on the morning of the 15th, and on about the 23rd, we have the prospect of witnessing two brilliant showers if the weather should prove favourable. In October many meteors are often seen from about the 18th to the 20th, from a radiant at 91°+15°, but the display is usually at its best in the morning hours.

THE FACE OF THE SKY FOR OCTOBER.

By A. Fowler, F.R.A.S.

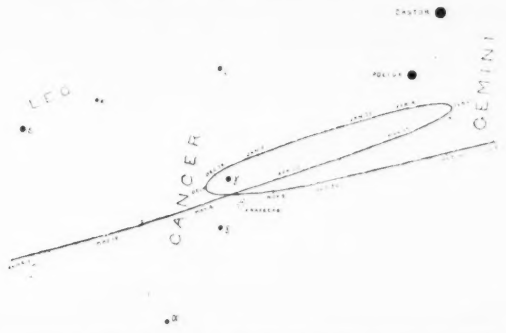
THE state of solar activity about the present time is very uncertain, but large spots can scarcely be expected, and one need not be surprised to find occasional spotless days. Nevertheless, the appearance of the great spot of last month warns us not to imagine that the actual sun-spot minimum is close at hand.

Mercury is a morning star during the early part of

the month, reaching the point of superior conjunction on the **19th**.

Venus is an evening star, and will reach her greatest brilliancy on October **27th**. Throughout the month she sets about an hour after the Sun. On the **15th** only one-third of the disc will be illuminated, and as the apparent diameter will then be 34·0″, very small telescopes will suffice to show the crescent phase. The apparent diameter increases from 28·0″ to 43·8″ during the month.

Mars is gradually coming into a more favourable position for observation, but the approaching opposition is by no means a good one for telescopic work. His apparent movement during the next few months, however, will be well worth the attention of young observers, and as a companion to such observations we give a diagram illustrating his path. He will rise shortly after ten on



Apparent Path of Mars, October 1st, 1898—June 1st, 1899.

the **1st**, and about half-past nine towards the end of the month. The planet will be in quadrature on the **17th**, and 0·88″ of the disc will then be illuminated, while the apparent diameter will be 8·0″. As will be seen from the diagram, his path is in Gemini during October.

Jupiter is in conjunction with the Sun on the **13th**, and will not be observable.

Saturn is still an evening star, but is getting too near the Sun to be well observed. At the beginning of the month he sets about two hours after the Sun, and at the end about one and a half hours after. The apparent minor axis of the ring is still greater than that of the planet, the respective values at the middle of the month being 16″ and 14·4″, while the major axis of the ring is 36″. He may be found about 6° north of Antares at the beginning of the month, and afterwards a little to the east of that point.

Uranus also remains an evening star, but is still nearer the Sun than Saturn, and may be considered as not observable.

Neptune, in Taurus, rises about 9 P.M. at the beginning, and about 7 P.M. at the end of the month, his apparent diameter being 2.6″. He is a little more than 1½° north-east of ζ Tauri.

The Moon enters her last quarter on the **7th** at 6.5 P.M.; is new on the **15th** thirty-seven minutes after noon; enters the first quarter on the **22nd** at 9.9 A.M.; and is full on the **29th** eighteen minutes after noon. On the **19th** she will occult the star B.A.C. 5878, Mag. 6½. The disappearance will take place at 4.50 P.M., 73° from the vertex, and the reappearance at 6.1 P.M., 239° from the vertex, the Moon's age being 4d. 4h., and the time of sunset 4.57 P.M. On the **22nd**, ρ Capricorni, Mag. 5, will be occulted; disappearance at 5.5 P.M., 28° from the vertex, and reappearance at 5.51 P.M., 303° from the vertex. The Moon's age will be 7 days, and the time of sunset 4.50 P.M.

Conveniently observable minima of Algol will occur on the **5th** at 9.58 P.M.; on the **25th** at 11.40 P.M.; and on the **28th** at 8.29 P.M.

Mira Ceti is near a maximum.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of September Problems.

No. 1.

(By B. G. Laws.)

Key-move—1. Kt to K6.

If 1 . . . K to B4, 2. Kt to Kt5, etc.
1 . . . R × P, 2. Kt to B2ch, etc.
1 . . . K to B6, 2. Kt to Kt5ch, etc.
1 . . . K to Q6, 2. Kt mates.
1 . . . K to Q4, 2. Q mates.
1 . . . Kt to B5, 2. Q to Kt2ch, etc.
1 . . . R to Q6, 2. Q to B4ch, etc.
1 . . . P × P, 2. Kt to B5ch, etc.

No. 2.

(By A. C. Challenger.)

1. Q to B3, and mates next move.

Correct Solutions of both problems received from Alpha, J. T. Blakemore, H. S. Brandreth, H. Le Jeune.

Of No. 2 only, from G. G. Beazley, J. M'Robert, W. de P. Crousaz, W. Clugston.

Mr. J. Nield, the composer of the August problems, points out that No. 2 is rendered sound by the addition of a Black Pawn at K7.

W. Clugston.—Thanks for your problem, which is marked to appear next month.

Notice.—Will contributors kindly observe the permanent change of address notified at the head of this column.

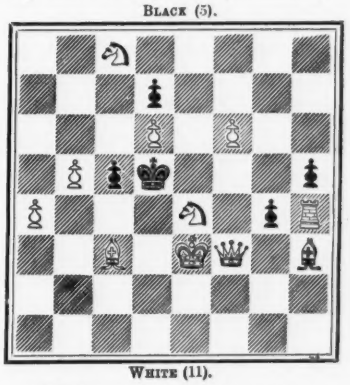
The following problems obtained first prizes in the recent *Brighton Society* tourney.

PROBLEMS.

No. 1.

By Rev. J. Jespersen (Denmark).

Black (5).



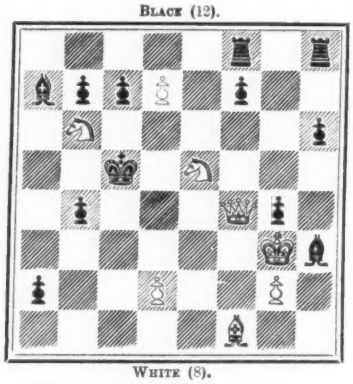
White (11).

White mates in two moves.

No. 2.

By Dr. C. Planck (Haywards Heath).

Black (12).



White (8).

White mates in three moves.

CHESS INTELLIGENCE.

In the Cologne Tournament the leading scores were:—A. Burn (First prize), 11½; Charousek, Cohn and Tchigorin, 10½; Steinitz, 9½; Schlechter and Showalter, 9; Berger, 8; Janowski, 7½; Popiel and Schiffers, 7. There were sixteen entries, seven of whom had just finished their arduous struggle in the Vienna tourney. Mr. Burn was again in fine form: we do not remember that an Englishman has won any international tourney since Blackburne's famous victory at Berlin in 1881. Mr. Burn lost one game only, to Showalter. Of the others, Charousek quite maintained his high reputation, Tchigorin did much better than at Vienna, and Janowski much worse.

The important Amateur Tournament of the Southern Counties Chess Union began at Salisbury on September 12th. A very strong list of entries was expected in Class I.

Game played in the Cologne Tournament:—

"Falkbeer's Counter Gambit."

White. (R. Charousek.)	Black. (J. Berger.)
1. P to K4	1. P to K4
2. P to KB4	2. P to Q4
3. KP × P	3. P to K5
4. P to Q3 (*a*)	4. Kt to KB3
5. Q to K2	5. Q × P
6. Kt to Q2	6. B to KB4
7. P × P	7. B × P
8. P to KKt4 !	8. Q to K3 (*b*)
9. P to B5	9. Q to K2
10. Kt × B	10. Q × Kt
11. Q × Qch	11. Kt × Q
12. B to Kt2	12. Kt to Q3
13. B to B4	13. Kt to Q2
14. Castles	14. Castles
15. Kt to B3	15. P to KR4 ?
16. Kt to Kt5 !	16. P to KB3 (*c*)
17. Kt to K6	17. R to Ksq
18. P to KR3	18. Kt to K4
19. B × Kt	19. P × B
20. KR to Ksq	20. P × P
21. P × P	21. R to R5
22. B to B3	22. P to KKt3 (*d*)
23. Kt × B	23. R × Kt
24. P × P (*e*)	24. R × B
25. P to B4 (*f*)	25. P to Kt3 (*g*)
26. P to B5	26. P × P
27. P to Kt5	27. R to Bsq
28. R × P	28. R to Ktsq
29. R × P	29. R × P
30. R to Q3	30. R to B5ch
31. R × R	31. Kt × R
32. R to Q5	32. Kt to Q3
33. Resigns.	

(*a*) This and the next move constitute the most fashionable modern defence. 5. Kt to QB3, on the next move, would allow Black to pin the Knight, with opportunities sometimes for P to K6 later on, if the White Bishop goes to Q2.

(*b*) Probably the best answer to White's fine move. There is no time for 8. . . Kt to B3; 9. B to Kt 2, Kt to Q5; 10. Kt × B! As it is, after the exchanges, White with his two Bishops remains with the better game.

(*c*) An unpleasant necessity, unless he likes to give up the exchange for a Pawn.

(*d*) All this is ingeniously played. White must now exchange in order to avoid the Bishops of opposite colours.

(*e*) A hallucination; apparently he overlooked that after 24. . . R × B, 25. P to Kt7, the other Knight's Pawn is no longer guarded; or, perhaps, the defence mentioned in the next note.

(*f*) If 25. P to Kt7, R × P; 26. R to Ktsq, R to Kt6!

(*g*) 25. . . R × P should be fairly safe here; if then, 26. P to B5, R checks; 27. K to Ktsq, R × P; 28. R to Ktsq, R to Bsq. The remainder is plain sailing.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 154 (August).

The Petroleum Industry.—III. By George T. Holloway, Assoc. R.C.S. (Lond.), F.I.C. (*Illustrated.*)
An Old-World Highland. By Grenville A. J. Cole, M.R.I.A., F.G.S. (*Illustrated.*)
Self-Irrigation in Plants.—II. By the Rev. Alex. S. Wilson, M.A., B.Sc. (*Illustrated.*)
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British Ornithological Notes. Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.
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Alexander Goodman More.
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Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.
The Face of the Sky for August. By A. Fowler, F.R.A.S.
Chess Column. By C. D. Locock, B.A.
Plate.—Artificial and Natural Faculæ.

Contents of No. 155 (September).

Whale Models at the Natural History Museum. By R. Lydekker, B.A., F.R.S. (*Illustrated.*)
Repetition and Evolution in Bird-Song. By Charles A. Witchell.
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Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.
The Face of the Sky for September. By A. Fowler, F.R.A.S.
Chess Column. By C. D. Locock, B.A.
Plate.—Copilia Vitrea (Haeckel) and Calocalanus Plumulosus (Claus).

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